ENGINEERING NEWS-RECORD

FEBRUARY 27, 1941

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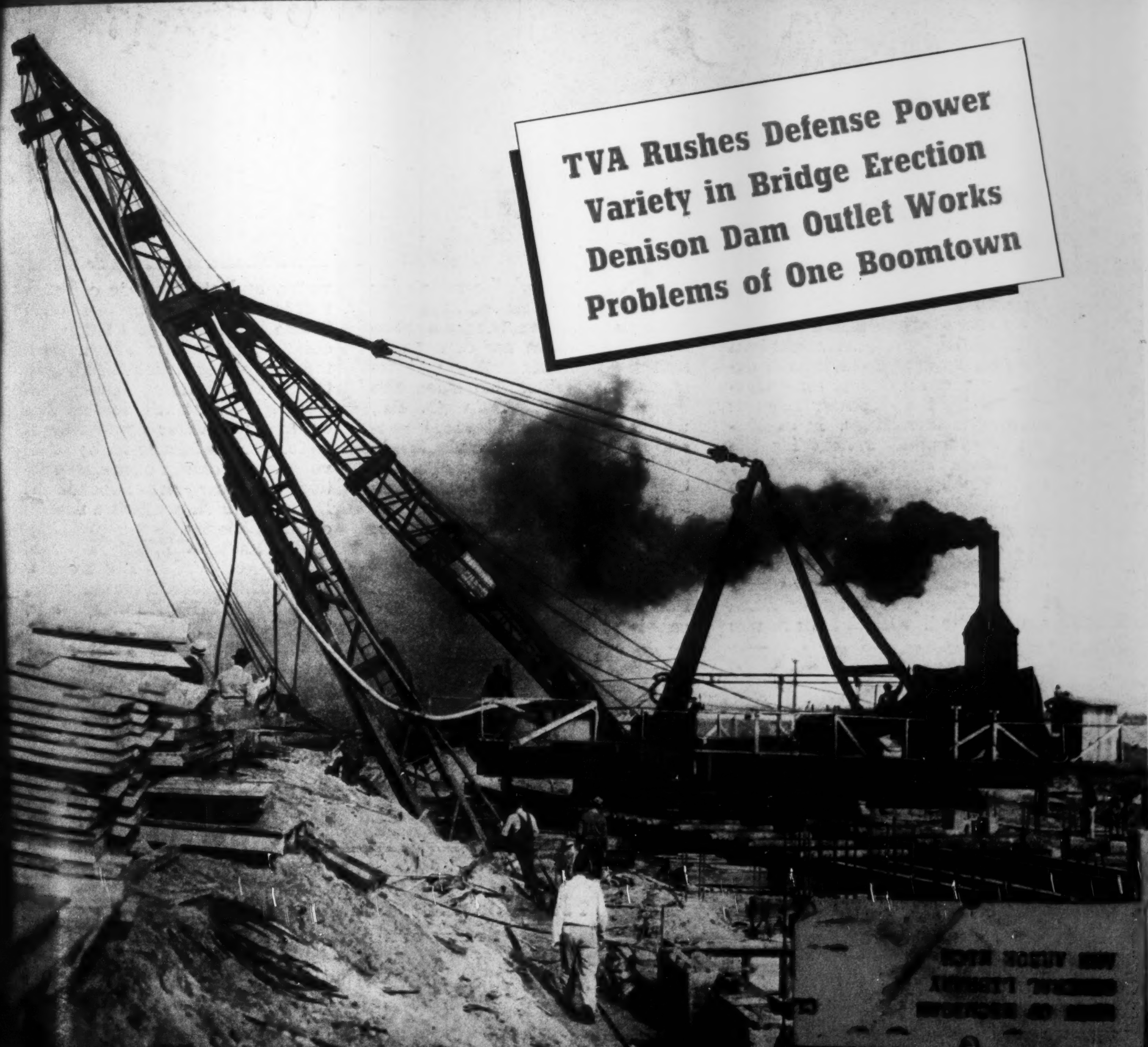
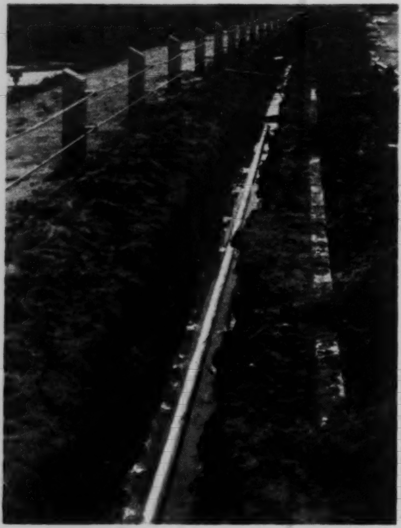
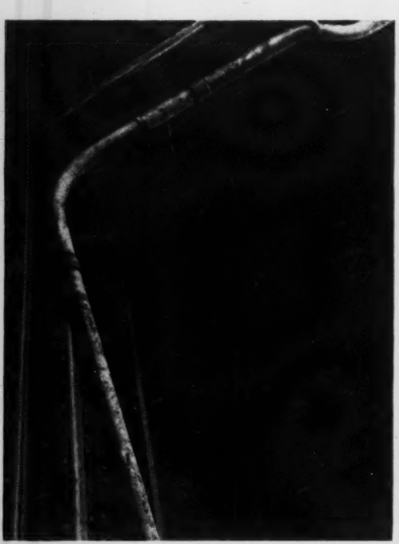
Driving concrete batter piles for a new 1,225-ft. wharf addition to the Alabama State Docks at Mobile



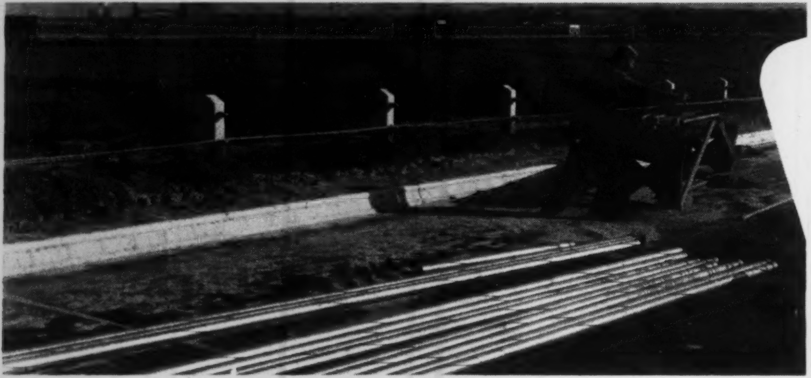
TVA Rushes Defense Power
Variety in Bridge Erection
Denison Dam Outlet Works
Problems of One Boomtown





15,000 FEET OF CONDUIT CORROSION PROBLEM SOLVED with

BYERS WROUGHT IRON

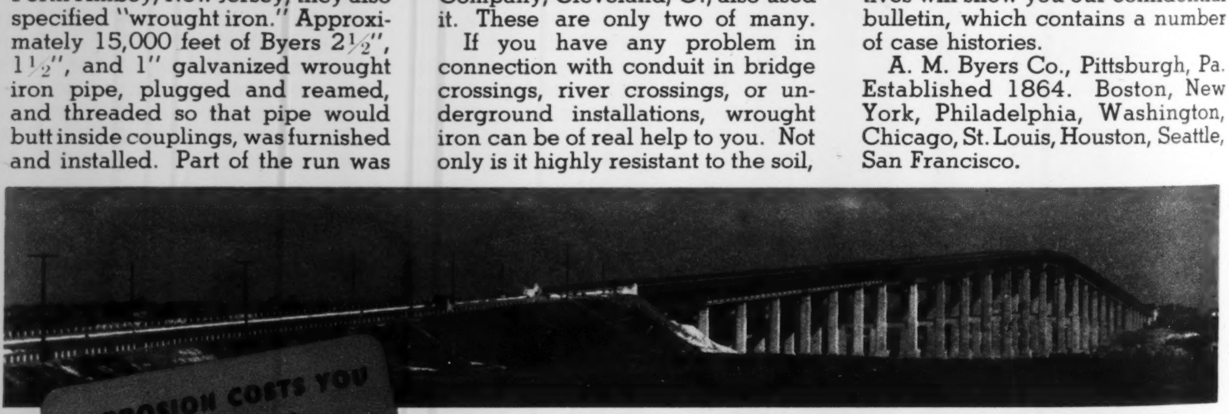


The State of New Jersey Highway Department is well acquainted with the permanent protection afforded to electrical lines by wrought iron conduit, as they have used it exclusively for some time for underground light and power lines at highway intersections. In designing the conduit system for the magnificent Thomas Edison Bridge, Perth Amboy, New Jersey, they also specified "wrought iron." Approximately 15,000 feet of Byers 2½", 1½", and 1" galvanized wrought iron pipe, plugged and reamed, and threaded so that pipe would butt inside couplings, was furnished and installed. Part of the run was made underground, the remainder on the bridge members, as shown.

Engineers all over the country are making extensive use of wrought iron for this demanding and responsible service. The Duquesne Light Company, Pittsburgh, Pa., used it on the East Bellevue, Homestead, Forbes Street and Neville Street Bridges. The Public Service Company, Cleveland, O., also used it. These are only two of many.

If you have any problem in connection with conduit in bridge crossings, river crossings, or underground installations, wrought iron can be of real help to you. Not only is it highly resistant to the soil, water, and atmospheric corrosion that is ordinarily encountered, but it also has exceptional fatigue resistance, an important factor when the supporting structure is subject to vibration. Our Engineering Service Department will furnish data on any particular application in which you are interested, if you will write . . . or one of our representatives will show you our confidential bulletin, which contains a number of case histories.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.



CORROSION COSTS YOU MORE THAN WROUGHT IRON

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WALDO G. BOWMAN, *Editor* • **ALBERT E. PAXTON, *Manager***

Vol. 126 FEBRUARY 27, 1941 No. 9

THIS WEEK

• The variety of steel erection methods used on the Ludlow Ferry Bridge across the Potomac River is reviewed in an article which describes construction operations on an 800-ft. cantilever and the erection of Wichert trusses from floated falsework.

• National defense activity is reflected in three separate articles which review: (1) design for typical Navy low-cost housing units; (2) boom town problems of a municipality near an army cantonment; and (3) the TVA program to rush more hydro power production.

• Construction of the outlet works for Denison Dam required a plant of unusual design for handling concrete over an area 1,632 ft. long by 256 ft. wide featuring a 1,660-ft. traveling cableway.

THINGS TO COME

• Those many readers who are interested in the Tacoma Narrows Bridge failure, but do not relish rigorous mathematical discussions of the subject, will find instructive reading in an article that might well be titled "The Evolution and Decay of the Stiffening Truss," which will appear in the March 13 issue.

• Solution of interesting foundation problems provides the feature of an article which will describe the Claytor hydro plant, recently completed on the New River in Virginia.

• Recovery of grease from sewage in England is reviewed as a sidelight in Britain's war effort.

• The modified design of Mud Mountain Dam provides a rockfill with an earthfill core. The new design of this record-breaking structure is to be outlined.

• Highway loadings, as modified for modern military requirements will be reviewed from the current report of the PRA.

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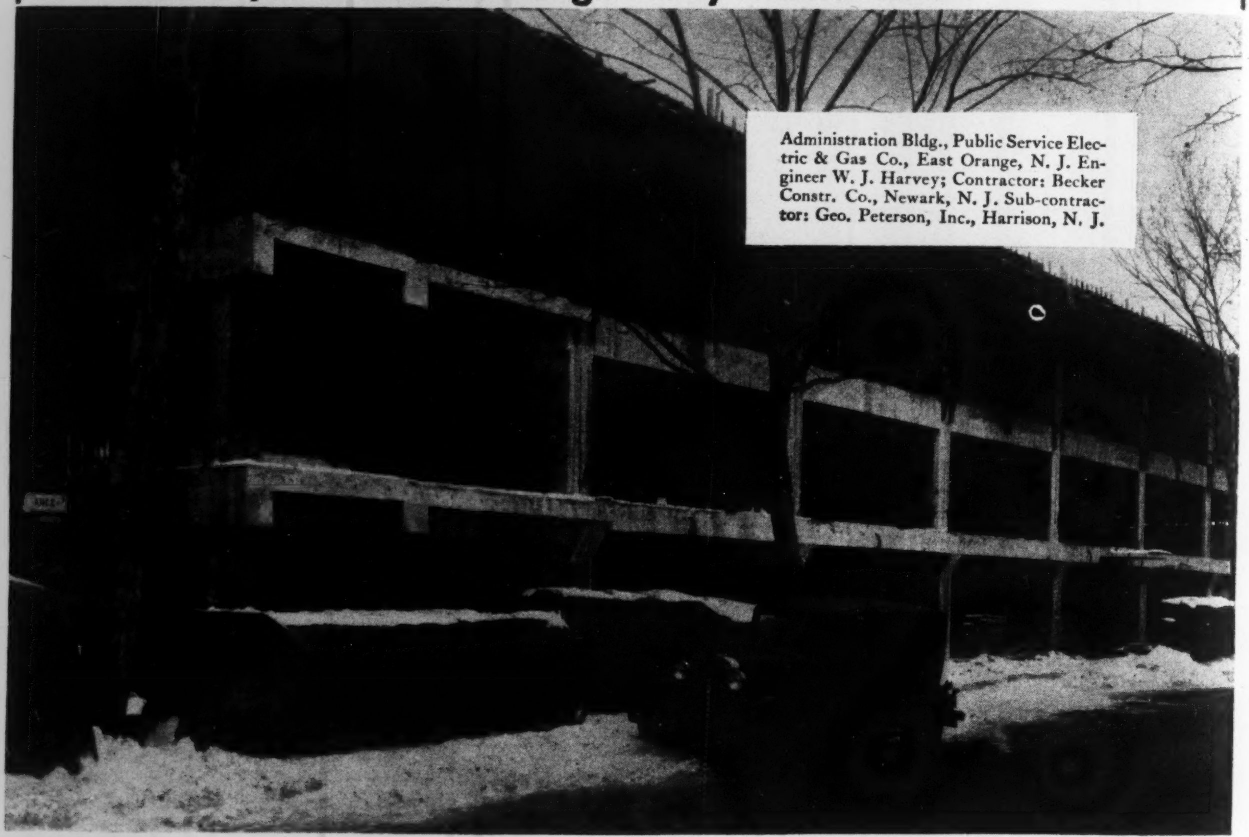
CASE #67

On the job with Atlas High-Early Cement...



Administration Bldg., Public Service Electric & Gas Co., East Orange, N. J. Engineer W. J. Harvey; Contractor: Becker Constr. Co., Newark, N. J. Sub-contractor: Geo. Peterson, Inc., Harrison, N. J.

7 DAYS' CONCRETING TIME SAVED ON EACH FLOOR

HERE'S a case, reports Geo. Peterson, Inc., subcontractor on concrete, where Atlas High-Early cement cut concreting time ⅓, and materially reduced form costs and protection and curing costs.

Here's his story: Instead of waiting 14 days to strip forms, necessary if standard portland cement had been used, column and beam forms were stripped on the fourth day after placing Atlas High-Early concrete. After re-shoring, the forms were re-erected on the next floor on the fifth day. On the seventh day, plywood forms were removed from the floor slab, which measured 70′ x 200′ x 8¼″ thick, and re-used on the next floor. Seven days per floor were saved, and only one set of forms instead of 1¾ sets of forms was necessary.

Average temperature during concrete construction was 28°; yet protection and curing time was cut from five days to two days by use of Atlas High-Early—a saving of three days per floor.

This is typical of the savings contractors are making everywhere with Atlas High-Early cement. Send for interesting folder, "Case Histories of Days and Dollars," which shows how Atlas High-Early cement can save time and money for you on many jobs. Universal Atlas Cement Co. (United States Steel Corp. Subsidiary), Chrysler Bldg. N. Y. C.

OFFICES: *New York, Chicago, Philadelphia, Boston, Albany, Pittsburgh, Cleveland, Minneapolis, Duluth, St. Louis, Kansas City, Des Moines, Birmingham, Waco.*

NR-H-28

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • FEBRUARY 27, 1941

$150,000,000 requested for help of defense towns

President urges Congress to provide money to extend water and sewer systems in towns that have been expanded to house defense workers

President Roosevelt on Feb. 24 sent to Congress a special message asking for an appropriation of $150,000,000 to be used to help towns where the population has been increased greatly by the influx of defense workers. Sanitary services in many of these towns are overtaxed by the sudden growth, and extensions of streets, power and transportation services are needed.

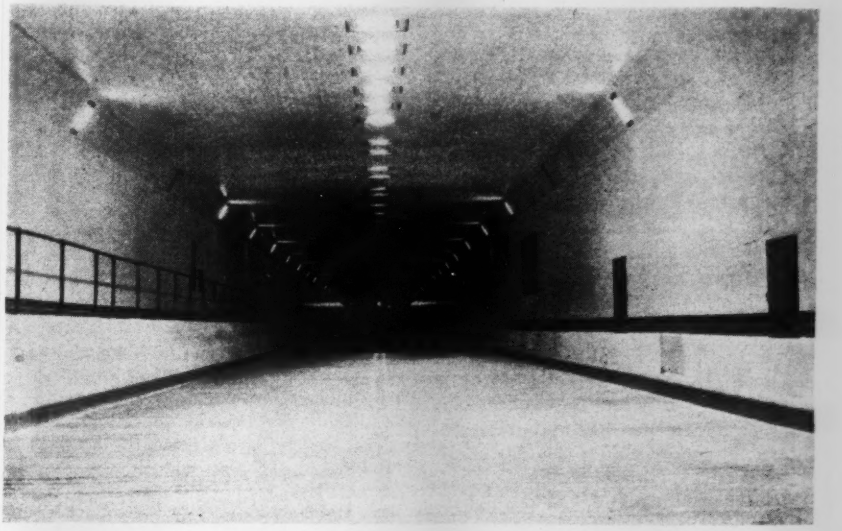
Provision for meeting this need was made in an amendment to the Lanham Bill last week (*ENR*, Feb. 20, p. 293) but that has been withdrawn. The money would go to whatever agency the President determines. Nothing is said in the President's message as to the terms on which the money is to be made available to the towns.

In laying his request before the Congress, President Roosevelt said, "The national defense program has required a large expansion of existing military and naval establishments. The government has constructed new cantonments, air depots and naval bases. We have financed and stimulated the construction of hundreds of new industrial plants to produce airplanes, guns, powder, ships and tanks. This program has been spread throughout the country and has resulted in new concentrations of military forces and civilian workers.

"Military and naval strategy has been the controlling factor in determining the location of many of these new defense establishments. As a result posts and plants have been necessarily located near communities without adequate public facilities and services for the large number of workers who arrived to construct them and who will be needed to operate the new establishments. There have been shortages of housing, insufficient sanitary and health facilities, overcrowding of transportation services, and inadequate recreational facilities. In fact, this shortage of essential public facilities has handicapped our rearmament effort in some areas.

"The provision of such community facilities has always been a local responsibility. It still is today; cities generally have been straining to meet the problem. Yet we must face the fact we cannot expect local governments to assume all the risk of financing the entire cost of providing new public facilities for the defense program."

The President this week asked Congress for immediate appropriation of an additional $262,040,000 of military construction money. At the same time, however, he reduced the same items in the budget for the fiscal year 1942 by $63,220,000 leaving a net increase in construction requests of $198,820,000. The new requests include $104,425,000 for army construction by the Corps of Engineers at the new Atlantic naval bases. Also asked is $145,238,000 for quartermaster construction at military posts which is balanced by a $58,000,000 reduction in the 1942 budget. Appropriation of $12,377,000 for seacoast defenses is set against a $5,220,000 reduction in the budget.



Vehicle tunnel at Mobile opened to traffic

A 3,400-ft. vehicle tunnel under the mouth of the Mobile River at Mobile, Ala., was opened to traffic on Feb. 20. Originally, the tunnel was scheduled to be opened last July but bad ground under the Mobile waterfront delayed its completion. It cuts off 7½ miles of distance on the route into Mobile from the east.

The tunnel is made up in large part of circular steel and reinforced-concrete sections built on dry land and sunk in a trench dredged across the river bottom. Approaches are of rectangular steel-bent construction built in open cut. A single roadway, 21 ft. wide, provides for one lane of traffic in each direction. For further details see ENR April 25, 1940, p. 572.

The tunnel was built by the city of Mobile at a cost originally estimated at $4,000,000 made up of a PWA grant and an RFC loan. It is to be operated as a toll facility. Wilberding & Palmer, Washington, are the engineers and the principal contract is held by the Arundel Corp., Baltimore.

Boston completes new link in subway system

Boston's new subway under Huntington Ave. in the Back Bay section of the Hub was officially opened to traffic, Feb. 16. Extending approximately one mile southwest of Copley Square, the subway removed all surface cars between the Boston Opera House and Arlington St., and saves from 10 to 20 min. per round trip between Park St. and Opera Place.

The tracks were laid in separate tubes and an underpass for vehicular traffic was provided at Symphony Hall at the intersection of Massachusetts and Huntington Aves.

Working under direction of WPA, approximately 2,800 men required three years to complete the structure, which was done without a single fatal accident. The cost of the project was $7,125,937. The project was carried out by the engineers of Boston Transit Department, T. F. Sullivan, chairman, and Wilbur F. Davis, chief engineer, for the Boston Elevated Railway.

Defense activity speeds housing under FHA

A total of more than $550,000,000 in new home construction has been started since July 1, 1940 by private capital operating under the FHA program, according to announcement by Abner H. Ferguson, FHA Administrator.

During the seven and one-half month period, when rapid expansion in defense industries was creating a strong need for additional housing, private builders started construction of 105,920 new small homes under FHA inspection. This is an increase of 31.7 percent over the similar previous period, when 80,427 new homes were started.

Of the total construction under FHA inspection since last summer about 85 percent was in important defense industry areas, the increases in these areas ranging up to 200 percent as compared with a year ago.

Expansion of private building in strategic industrial areas has been encouraged, states administrator Ferguson, by the general policy of limiting direct governmental construction of housing under the defense program to situations presenting excessive risks or other conditions unsuitable for private operations.

During the last six months of 1940 a total of 88,811 new homes were started under FHA, an increase of 29.5 percent over the corresponding period of 1939. In addition, since the first of the new year, the gain over a year ago has broadened to 44.3 percent, a total of 17,109 new homes having been started up to Feb. 15, against 11,860 in the same period of last year.

• • •

Bill before congress for continental road network

A continental network of superhighways, similar to the new Pennsylvania Turnpike, has been placed before Congress in a bill introduced by Representative Snyder of Pennsylvania. The bill provides for three transcontinental and six North-South highways of eight lanes, with an additional right of way of about 500 ft. on each side. Representative Snyder estimated that the cost of the 16,000 miles that would be covered by the network would cost approximately $8,000,000,000 including the purchase price of the land.

• • •

Georgia Legislature comes to aid of road contractors

Georgia's Governor Eugene Talmadge, Feb. 12, sent an urgent message to the Georgia legislature for help in his controversy with highway contractors, pointing out that the state highway department owed approximately $4,000,000 to contractors legally due for past service. Some contractors had received certificates, bearing 7 percent interest, but the payment of interest was invalidated by the new state highway board. The governor urged the house to adopt a resolution authorizing the road department to issue certificates of indebtedness without interest to these contractors, which would make possible the discounting of the paper and thus satisfy all concerned.

The House Rules Committee acted immediately with recommendation that a resolution be passed giving the governor the authority requested, and shortly afterward the house adopted it.

• • •

Overtime rate cut on defense construction

Rate of overtime pay after 40 hours will be not greater than time and a half on defense construction work, the unions of the AFL Building Trades Department decided at a meeting last month. At present, on cost-plus-fee jobs, overtime is being paid after forty hours and on Saturdays, Sundays, and holidays. Rate of overtime is in accord with prevailing local practice—which, in some localities and for some trades, runs considerably higher than time and a half.

The executive council of the Building Trades decided last month not to ask more than time and half. This cannot apply immediately to two unions—the ironworkers and the lathers—because these have double time written into their constitutions, which can only be amended by convention. What the effect would be in those areas where straight time up to 44 hours is customary is also not clear.

No official announcement of this decision has yet been made. It is understood that formal promulgation of the new policy is waiting on completion of negotiations with the government.

Contractors review their job in defense program at annual A. G. C. meeting

Also study labor relations, legislation, and safety as about 900 gather at Houston for 22nd annual convention

At their 22nd annual convention in Houston, Tex., Feb. 17–20, the Associated General Contractors of America paused for a moment to review their part in building for defense, found it good, and turned forward with a renewed pledge to army, navy and defense officials to carry on the construction requirements of the emergency program with speed and efficiency. The meeting was addressed by outstanding defense authorities, including Maj. Gen. Julian L. Schley, chief of engineers, U. S. Army; Brig. Gen. Grehon Somervell, chief, construction division, quartermaster general's office; Brig. Gen. J. W. Schulz, in charge of procurement, office of Secretary of War; Commander L. N. Moeller, U. S. Navy, in charge of the naval base construction at Corpus Christi; Wm. H. Harrison, chief, ships, construction and supplies, office of production management; and H. K. Bishop, public roads administration. John P. Coyne, president, building and construction trades department, A. F. of L., maintained the tradition of a labor leader speaking to the contractors started at San Francisco two years ago. The convention was the largest in the history of the A.G.C. with nearly 900 in attendance.

Although defense construction dominated the convention, by no means was this the sole topic of the meeting. Labor relations, legislation, safety, and other vital items were also discussed. WPA was criticized in a resolution for trying to take over the public works construction of the country and perpetuate itself beyond the needs of relief.

Defense construction

Gen. Somervell made the outstanding talk of the convention. In his earnest, forceful manner, he declared that the pledge of the construction industry last July to do the job has been fullfilled, that the challenge to contractors and labor has been met, and that the "defense construction program is in good hands." He expressed appreciation of the efforts of the A.G.C. and stated that "It's a wonder so much has been accomplished in such a short time."

In no uncertain terms Gen. Somervell announced that graft and unnecessary waste have no place in the construction program. Integrity is the watchword of this program, he declared, and the record of honesty must prevail. He asked for the utmost economy in the work.

Gen. Schley outlined the defense construction under the direction of the army engineers, the largest part being the building of airfields, hangars, depots and schools for the army air corps at 80 stations.

Another large order for the army engineers, stated Gen. Schley, is the construction of army bases at the eight west Atlantic locations leased from Great Britain.

In commenting on the regular work carried out by the corps of engineers for years, Gen. Schley stressed the defense value of flood control and navigation projects. He pointed out, however, that appropriations for regular river and harbor and flood control work may be curtailed during the defense emergency.

Wm. H. Harrison, principal speaker at the annual banquet, complimented the contractors on their part of the program, and declared there were now 700,000 construction workers busy at 500 locations. Harrison concluded with the ominous warning that "The race is yet to be run."

Gen. Schultz dwelt at length upon the problems of procurement for defense. For the army alone, he stated, $7,000,000,000 had been appropriated for the present fiscal year, and for the last three and a half months obligations have been placed at the rate of one and a quarter billions per month.

H. K. Bishop represented his chief, Thos H. MacDonald of the Public Roads Administration, in outlining the recent PRA report on defense roads (*ENR*, Feb. 20, 1941, p. 289). The funds proposed to be added to regular federal aid will provide $500,000,000 federal participation in highway building for the coming fiscal year.

The defense program has brought a new interest to contractors in navy shore facilities construction. Commander Moeller presented some impressive figures to indicate the magnitude of the navy work being carried out by the bureau of yards and docks. From July, 1916, to December, 1937 (including World War days) the bureau spent $361,265,000. In the seven-month period from June 1, 1940, to Jan. 1, 1941, the bureau awarded contracts totaling $395,000,000, or 9½ per cent more than the 21½ years mentioned above. From Dec. 1, 1937, to Jan. 1, 1941, contract awards totaled $540,000,000.

The negotiated contract for both engineering and construction services was highly praised by Commander Moeller as being most effective in speeding up design and building of shore facilities. As an example he cited his own project, the naval air base at Corpus Christi. Under normal lump-sum contract procedure, this $28,000,000 project would have required 3½ years to build; under the negotiated fixed-fee system it will be ready for commissioning Mar. 12, 1941, 8 months after title to the site was obtained, and the original construction program will be completed June 30, less than a year from start of work. This represents an expenditure of over $2,000,000 monthly without, Commander Moeller maintains, waste of money.

Labor relations

Ever since October, 1937, labor relations have been an important activity of the A.G.C., and this is the third consecutive time that an official of the A. F. of L. has addressed the annual convention. John P. Coyne, in his talk this year, pointed out that E. J. Harding of the A.G.C. and John Possehl, of the A. F. of L., both of whom died last year, brought the two organizations together. He praised the cooperation the contractors were giving, and officials of the A.G.C. returned the praise in subsequent discussions.

Mr. Coyne stated that a survey at the start of the defense program revealed 370,000 skilled tradesmen available in the 19 international unions making up his department; the main problem was to get the required labor to the point of need. The A. F. of L., he stated, has moved workers half way across the country to man defense construction projects, at no cost to the contractor or the government. As a result, he maintains, these has been no serious shortage of skilled labor on any vital construction job.

In discussing labor problems Mr. Coyne disappointed his listeners by omitting any reference to the collection of reported high fees and dues by local unions from new members on defense jobs. Many contractors had hoped he would justify or explain the practice so they could give an explanation to a practice for which contractors are being severely criticized.

E. P. Palmer, chairman, and J. D. Marshall, secretary, A.G.C. labor committee, reported at various times on the labor relations of the association. No serious jurisdictional dispute has occurred, they stated, since the agreement on this controversial subject has been in effect.

Public relations

Last spring at the Milwaukee meeting the association took its first steps toward better public relations and publicity by appointing a committee, headed by Morris DeWitt to report at this convention. In connection with the committee's report, H. W. Richardson, Western Editor, *Engineering News-Record,* pointed out the need for a public relations program for the A.G.C. and the contracting industry. Contractors, he stated, are unknown and without friends among the general public because for years they have discouraged publicity, have failed to sell themselves to the public as an indispensable industry in the national economy, and have met the public through unfavorable circumstances of strikes, accidents, detours, inconvenience because of construction operations, and controversies over increased costs beyond their control. He advocated cultivating the press, liberal use of signs on the job, development of the "Sidewalk Superintendents" idea, and the establishment of a public relations department on the national staff of the A.G.C. The 95 chapter secretaries and managers, he stated, can do a lot towards bettering local public relations, but their efforts will be much more effective if coordinated and supplemented by a national staff.

The public relations committee report asked for a new staff member to direct publicity work. After considerable discussion the convention directed its officers to poll the various chapters in view of determining the membership's attitude toward supplemental payments for publicity work, as the coming year's budget had already been accepted and closed.

Association activities

The past year's activities and general plans for the future were outlined in the annual report of H. E. Foreman, new managing director of the A.G.C. He recalled the work the association did in helping to get the defense program under way, and stated that the general contractors were ready for anything they might be called upon to do in the future. National defense construction, he pointed out, calls for execution with utmost speed and efficiency on the part of general contractors. Their work is needed in a hurry to make other defense measures possible, and, too, he warned, a failure of any kind by general contracting—or any other industry—invites federal domination. Furthermore, he stated, the greater success of general contractors in carrying out their part of the defense work, the stronger are their arguments that WPA has no place in the program of construction activity.

Many problems of contractors were discussed in the three divisional meetings that took up one whole day of the convention. Highway, building and heavy contractors met separately to talk over their particular problems. Some of the divisional meetings were addressed by outsiders.

Lack of space prevents discussion of all of the talks and papers that were presented, both at the general sessions and the divisional meetings. Delegates were unanimous in stating it was the most interesting and best-attended convention held during the 22 years of the life of the association.

New officers

H. E. Foreman was welcomed as the new managing director appointed following the death of E. J. Harding last October. A short memorial service was held for Mr. Harding. J. D. Marshall, appointed assistant managing director, also received a warm welcome.

National officers installed at the convention were: President, M. W. Watson, Topeka, Kans.; vice-president, Dan W. Kimball, Grand Rapids, Mich. Chairman and vice-chairman of the three divisions were named as follows: Highway, F. C. Nelch, Springfield, Ill., and J. H. Pittman, Houston, Tex.; Building, M. J. Cummings, Jr., Boston, Mass., and Wm. Ryberg, Salt Lake City; Heavy and railroad, Harry Dick, Portland, Ore.; and L. C. Rogers, Chicago, Ill.

The Secretaries Council held several meetings during the convention and named Frank Connolly, Los Angeles, Calif., Loy W. Duddlesten, Houston, and J. A. Higgins, Cincinnati, as new officers.

Much credit for the success of the convention and for the exceptional entertainment provided goes to Russell Nix, Houston, convention chairman, and Loy Duddlesten, Secretary of the Houston Chapter and Chas H. Newell, secretary of the Texas Highway Chapter.

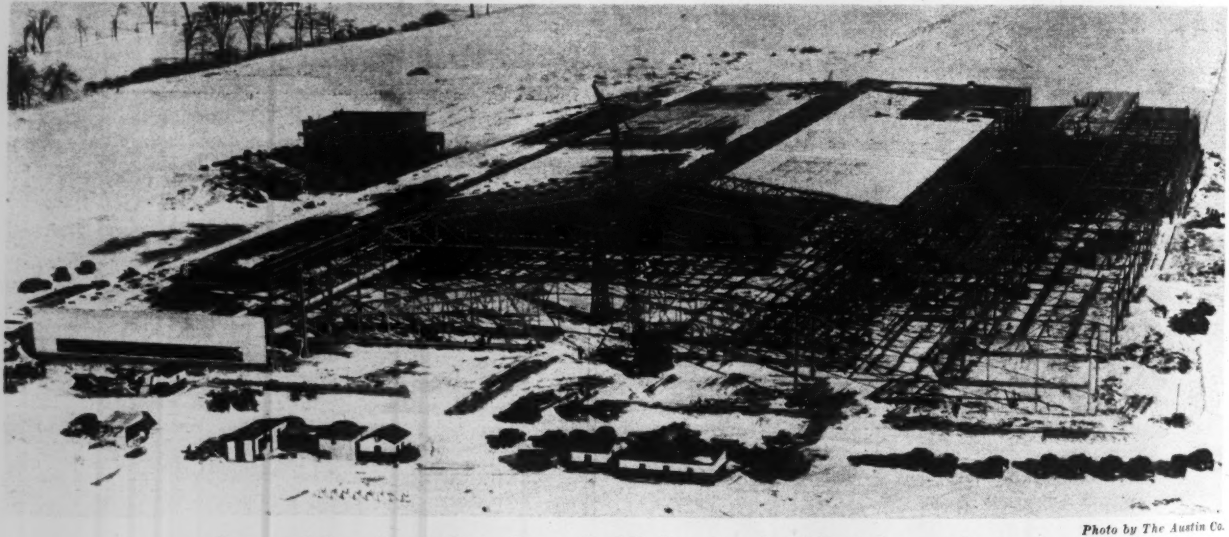


Photo by The Austin Co.

Assembly plant for Army's high-speed Airacobra planes

Construction of Bell Aircraft Corporation's new $1,050,000 assembly plant at Niagara Falls, N. Y. is going forward rapidly despite the handicap of excessive cold weather. In this plant will be assembled the Army's high-speed Airacobra intercepter pursuit planes, parts being delivered from their Buffalo plant.

Approximately 2,000 tons of structural steel will be required to complete this structure which will have a floor area of 300,000 sq.ft., two-thirds of which is already under roof. The main assembly space will be 200 ft. wide with a clear area of 40,000 sq.ft. Finishing touches on assembly will be handled in this department. Four 50-ft. bays, for sub-assembly, two on either side of the high center section, will contain four additional assembly lines, set up in two 100-ft. bays, each 600 ft. long, and with 30-ft. clearance below the roof trusses. From the final assembly space planes will be moved out onto the airfield apron through a 195-ft. overhead canopy door. The Austin Co., Cleveland, Ohio, are designers and builders of the structure.

Latest Concrete Knowledge Reviewed by Am. Concrete Institute

Program of annual convention in Washington was one of widest diversity in Institute's history. Admiral Moreell is new president.

Although not exceptionally large in point of attendance, the 37th annual convention of the American Concrete Institute, held in Washington, D. C., Feb. 18-20, was, on the other hand, characterized by an unusual program of papers that blanketed the field from research through design, construction, maintenance and repair. Outstanding perhaps were discussions of cracking troubles at Parker Dam, of lean road mixtures in Texas, of fire-damaged concrete in Buffalo, N. Y., and of the use of frame instead of bearing-wall construction in some housing projects. Total registration at the meeting was 343.

Rear-Admiral Ben Moreell, chief, Bureau of Yards and Docks, U. S. Navy, one of the nation's top concrete authorities and a long-time leader in the A.C.I. was elected president to succeed R. B. Young, of Toronto. At the annual banquet Benjamin F. Affleck, former president of the Universal Atlas Cement Co., was presented with a certificate of honorary membership. The Wason Medal for the most meritorious paper went to R. E. Copeland and C. C. Carlson for their paper on tests of rain resistance of walls, and the Wason Medal for notable research to George W. Washa for his studies of hand-rodded and vibrated concrete. The banquet speaker, William H. Harrison, in charge of construction for the Office of Production Management, emphasized the increasing urgency of the defense effort and warned that normal civilian industrial activity is going to have to be reduced.

Cracks in Parker Dam

A paper not listed in the program proved to be the most significant and sensational of the convention, since it referred to the important question of alkali in cement.

Presented by H. J. Meissner and R. F. Blanks of the Bureau of Reclamation, it told how superficial cracks began to appear on the face of Parker Dam last summer, and how the face of the dam is now webbed with cracks, most of them hairline but some wide enough to insert a finger into. Tests of cores taken from the dam show that the modulus of elasticity has decreased markedly since the concrete was placed—from 4,800,000 to 2,200,000. Some reduction in compressive strength is also found. The dam, a Bureau of Reclamation structure, was finished in 1938.

The authors pointed out that the concrete was placed according to the best practice and with very close control. They attribute the trouble to a hitherto unconsidered chemical action between certain aggregates used in the concrete and the alkali in the cement. This action forms a jell which expands in the presence of moisture. Thus the inner portion of the dam, which is still wet, is expanding, while the dry outer six inches or so is contracting. This differential movement produces the cracks.

Most unusual feature of the Parker Dam experience is the speed with which the reaction developed. Somewhat similar effects have been observed, usually about nine years after the placing of the concrete, with certain western highway aggregates, Roy W. Carlson told the meeting. He has been carrying on experiments at M.I.T. in an effort to develop an accelerated test for the action. So far, he has been able to get the time down to about four months and hopes to reduce it farther. He finds that there is a "pesimum" temperature, in the neighborhood of 100 deg. F. at which the reaction proceeds fastest. There is also a definite pesimum particle size, and the action is faster with rich mortars. Addition of about 0.4 per cent free alkali to the mix also accelerates the action.

Some recent concrete jobs

One of the large groups of papers dealt with miscellaneous current jobs, most of them familiar to readers through previous articles in *Engineering News-Record*. Since the papers are also published in the A.C.I. *Journal*, only a few pertinent abstracts that bear directly on new concrete knowledge can be given here.

New York City's 85-mile Delaware Aqueduct tunnel is being lined with 2¼ million barrels of cement manufactured to special specifications developed by the Board of Water Supply under the direction of the late Thaddeus Merriman. Important provisions limit the alkali content, assure thorough burning of the clinker, and guarantee that moisture does not get to either clinker or cement until it reaches the mixer. The specification, in brief, seeks to control manufacturing procedure and, in the opinion of the Board of Water Supply engineers, does this with great benefit to the resulting concrete. Dense watertight concrete is sought for the tunnel lining by using a high cement factor—2 bbl. per cu.yd. (Papers by Charles M. Clark and George Span, New York City Board of Water Supply.)

In a paper on the problems presented by the Lake Washington concrete pontoon bridge, Charles E. Andrew, principal engineer, Washington Toll Bridge Authority, pointed out how water tightness (and as a corollary minimum shrinkage) was the necessary quality of the concrete used, and that this was obtained by using a cement factor of a 1.5 bbl. of cement per cu.yd. and a water-cement ratio of 0.73. The paper was presented by R. B. McMinn of the PRA and a consultant on the bridge.

Another big concrete job of the past year, the Pennsylvania Turnpike, required slightly over 2,000,000 bbl. of cement, which was bought under a normal specification, except for requirements for extra fineness (1600 sq. cem. per gr.), autoclave soundness, and increased time for initial set during hot weather. At least 10 per cent of the sand in the mixes used was required to pass the 50-mesh sieve, and even more fine material would have been desirable. (Papers by Hershey Miller and I. L. Tyler, Pennsylvania Turnpike Commission.)

Concrete practices in the building field were also described. In Chicago the 125 two- and four-story buildings in the Ida B. Wells low-cost housing project were designed for frame instead of the usual (for USHA work) wall-bearing construction by Carl A. Merz and Magnus Gunderson. Mr. Merz, in his paper, emphasized the advantages in speed of construction, in crackless walls and in brick masonry saving that the frame construction afforded. In discussion, A. M. Korsmo of the USHA denied that frame construction was cheaper than bearing wall structures now being built, and stated that USHA designed buildings have not exhibited wall cracks.

In six low-cost housing developments in Newark, N. J., and one in Atlantic City, Joseph Di Stasio, consulting engineer, New York, used a flat plate rigid frame design. Elimination of bearing walls in favor of frame construction on these jobs, too, is claimed to have increased both speed and economy. Using flat plate design (and slightly stronger spandrel beams) made it unnecessary for the wall columns to line up with the interior columns, which gave the architect welcome flexibility in room arrangement. He was also aided in this by the fact that there were no interior beams. The rigid frames were designed by the fixed point method, and slab moments were distributed according to A.C.I. code provisions.

In building the terminal building at the new Washington National Airport emphasis was placed on the handling of the concrete to obtain the best architectural effect. A paper by W. E. Reynolds, commissioner of public buildings, presented by George Sheldon, the project engineer, brought out some of the special features. Care was taken in proportioning the mix to achieve a uniform color, various brands of cement and types of aggregate being tried in preliminary tests. Then to prevent form bulging, spacing of the studs was reduced from the 12 or 16 in., common in the area, to 8 in. Forms were of $\frac{5}{8}$-in. plywood, to which a light application of lacquer had been applied. Only one reuse of the forms on visible surfaces was permitted, and first- and second-use panels were not combined on the same wall surface. Steel chairs were not used for reinforcing for fear steel rust might show through; instead, concrete blocks precast from the same mix were used. All forms were vibrated. Finally, in order to clean the surface and fill any air holes, a sand cement grout was floated over the finished concrete wall, usually about 50 ft. at a time, left on for 20 or 30 min., and then scraped off with the sharp edge of a trowel; final operation was rubbing with burlap.

Concrete under fire

Construction in concrete is generally referred to as fireproof, but periodically a conflagration occurs to emphasize that this characterization is not absolute. The disastrous fire in February, 1940, that gutted the nine-story warehouse of the General Mills Co. at Buffalo was one of these. Before the building, 316 x 76 ft. in plan, was entirely complete, and before the sprinkler system was in operation, it had been heavily stocked with cereal breakfast foods in wax paper packages, and these provided the fuel for the flames. The action of the fire, the damage sustained and the repair methods that put the building back in service were covered in a detailed paper by J. Fruchtbaum, Reecon Co., Buffalo, engineer in charge of the repair work. Temperatures to which the concrete was subjected ranged up to 2,000 deg. for a period of 10 or 12 hr.; one section sustained 1,400 deg. for 18 hr. Evidence of calcining was found in the most severely heated areas. Serious spalling occurred on floors and columns, due, in Mr. Fruchtbaum's opinion, to the character of the coarse aggregate which contained 10 per cent chert and 30 per cent quartz, materials that expand rapidly under heat.

Concrete strength loss varied from 10 to 65 per cent. Steel elastic limit was down as much as 20 per cent in some cases, but in others increases up to 11 per cent were found. Ultimate strengths of steel as well as ductility were generally reduced, up to 20 per cent in the hottest areas.

Concrete in pavements

In addition to the papers on the Pennsylvania Turnpike, pavement concrete received important additional recognition. Of most significance was the presentation (for discussion preliminary to revision and submission and adoption as an A.C.I. standard) of specifications for concrete pavements and bases, by H. F. Clemmer, chairman of the drafting committee. The specifications present "minimum requirements for satisfactory results under average conditions" and are regarded as meeting in excellent manner an important unsatisfied need.

Ben Moreell, New A.C.I. President

On Texas federal aid road work the Public Roads Administration has approved the use of concrete mixes using less than the usually required five bags of cement to the cubic yard, it was pointed out by E. P. Cape, materials and tests engineer of the Texas highway department. Mr. Cape said Texas in the past has used two different cement specifications. On federal aid roads, a water-cement ratio design has been used, at PRA insistence, requiring 5 sacks to the yard and not more than $6\frac{1}{2}$ gal. per sack. On its own roads, the state uses a specification merely requiring that a certain modulus of rupture of 7-day 6 x 6 beams be attained. The mix is designed in the laboratory using samples of the materials proposed to be used. First a water-cement ratio is determined which will give the required strength; then the smallest quantity of cement which will give a workable mix, with the most favorable combination of aggregate and sand, is found.

On this basis, the state has built about 23 mi. of road with only $2\frac{1}{2}$ sacks to the yard, 69 mi. with only $3\frac{1}{2}$ sacks, and 700 mi. with 4 sacks or less. Many of them have given satisfactory service for as many as eight or ten years.

Henry Jackson of PRA said he had been sent to Texas to study these roads and had substantiated the claims of the state. He found that the surface wore down rapidly, exposing the aggregate and giving a harsh honey-combed appearance. However, at this point the wear stops; there is no further disintegration, and an excellent non-skid surface is produced. Jackson attributes this situation to the high quality of the cement and aggregates available in Texas and to the favorable weather conditions. On the other hand it was also brought out in discussion that $3\frac{1}{2}$-sack roads had given good service in Wisconsin where weather, at least, is not so favorable.

PRA has now eliminated cement-factor requirements on Texas federal-aid work and is permitting water-cement ratios up to 8 gal. per sack. The changed policy applies only to Texas, however.

Building code adopted

The new A.C.I. Building Code, substantially revised from the 1936 tentative version, was adopted by voice vote. It will now be submitted to a mail ballot of the full membership. Some feeling was expressed at the meeting that the proposed definition of "concrete" which is restricted to portland cement mixtures, should be broadened to include concretes using natural cements, hydraulic limes, and puzzolans. The code committee argued that the provisions of the code are all based on the properties of portland cement concrete. A motion to change the definition was defeated.

A. R. Lord, a member of the committee, sent a statement protesting strongly against adoption of the new flat slab section. He said it permits, as an alternative, use of an untried and dangerous method of design, that structural failures might well result for which A.C.I. would be responsible. Mr. Lord's views were not made the subject of a motion.

Cement and concrete research

A session devoted to brief accounts of current research projects in the concrete field attested to a high degree of activity. The problem of measuring the alkali content of cement is under study at the Bureau of Standards, as is also the effect of using various grinding aids in the manufacture of cement.

In a test road in Ohio the effect of using a cement ground with 0.18 lb. of beef tallow per bbl. was to produce a concrete with reduced bleeding tendencies, greater air voids and lower tensile strength. The same effects, but less pronounced, were noted when vinsol resin was used instead of tallow. The Kentucky highway department obtained results similar to those above using vinsol resin and natural cement admixtures to improve the weathering characteristics of a test road at Fort Knox.

J. C. Pearson, Lehigh Cement Co., said that use of certain dolomitic marbles and some limestones as aggregates can cause extremely rapid disintegration because they have a low and sometimes negative coefficient of thermal expansion at low temperatures. He said tests must be made at low temperatures because the coefficient is quite different from those observed at or above room temperature.

Arch design

The committee on arches, Charles S. Whitney, chairman, presented for discussion a new method of reinforced concrete arch design eliminating the use of unit stress calculations which it is held are meaningless when it is attempted to take account of volume change effects. By the new method, thrusts and moments are calculated by the elastic theory and then the arch sections are proportioned so that these thrusts and moments do not exceed the useful strength of the sections. This useful strength is a proportion of the ultimate cylinder strength of the concrete, depending on the desired factor of safety and the permissible cracking. Economy in material and simpler design are claimed advantages.

Miscellaneous papers

A session billed as "ten minute presentations of papers of wide diversity" brought out a number of significant facts, and served to broaden considerably the scope of the program. H. F. Clemmer, Washington, D. C., began the presentations by describing and illustrating some of the new placing mechanisms, such as vibrators and mechanical spreaders. In comment, A. Levison, Blaw-Knox Co., pointed out that the present use of dry concrete (some of the Pennsylvania Turnpike concrete had a slump as low as 1½ in.) increased the need for mechanical placing equipment. Lion Gardner, Jaeger Machine Co., said that a 1918 contractor with the same investment in equipment as a modern contractor would get only one-third the output; the Turnpike would have cost twice as much in 1918. He said a single-drum 34-E paver is being developed, but its use is restricted by the requirement in some states that longer mixing time be required in large mixers; he suggested that this requirement be eliminated. He said ten states now specify vibration of highway concrete.

A study of carbon dioxide treatment to prevent efflorescence on abestos-cement shingles was described by C. R. Hutchcroft and H. R. Anderson (Keasbey & Mattison). Only the front face, it was found, need be exposed to treatment. Best results are obtained when the shingles are about five days old; are exposed to an initial CO_2 concentration running as high as 54 to 63 per cent; are at normal humidity rather than very wet or very dry; and are at room temperature.

T. C. Creagan described work he has done in rehabilitating a number of Canadian hydro dams which have begun to disintegrate because of original use of too lean a concrete. Procedure is to pressure grout from the downstream face without unwatering the dam. The procedure can only be used if there are water channels in the concrete through which the grout can travel. Pressures up to 100 lb. are used. As first step, a grout containing small quantities of sodium carbonate to induce quick setting is used to stop the flow of water. This is followed by a grout containing calcium stearate admixture to lubricate and retard set.

Emphasizing the advantage of large bars of high yield point steel (30,000-lb. working stress) now permitted by the A.C.I., Thor Germundsson, Chicago, described a column design using them. It is a 1,024-kip column 20 in. square, containing eight 2-in. bars arranged in a circle with spiral reinforcement. Cost of this column, for a 12-ft. story, is $88. For comparison, he presented a conventionally designed column, for a 1,047-kip load, 31 in. square, with 16 1½-in. normal bars. This cost $134. Prof. M. O. Withey pointed out that the high bond stresses encountered in this type of construction calls for care in design.

Hollow girders of 41-ft. span were designed by Homer M. Hadley (Portland Cement Association, Seattle, Wash.) for a sack house for Superior Portland Cement, Inc., and described by him in a paper. In general the design followed that outlined by Mr. Hadley in an *ENR* article Dec. 19, 1940, p. 838.

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Provo Canal work to start in spring

Work on the Provo canal project, near Provo, Utah, will be started in the early spring, according to announcement by Commissioner John C. Page of the U. S. Bureau of Reclamation. The Deer Creek Dam is nearing completion, work on the Salt Lake Aqueduct is well advanced, and construction on Duchesne Tunnel is now under way, which will enable the work to go forward on Provo reservoir canal, as well as enlargement of the Weber-Provo diversion canal; all of these units form part of the Provo River project.

Although the budget asked for only $1,250,000 to continue work on the Provo River project, commissioner Page finds there will be ample funds to meet all immediate needs because of the substantial amount remaining unexpended out of past appropriations and allocations. Up to Dec. 1, 1940, $3,650,000 had been spent on this project. The Provo reservoir canal will be 23-mi. long and will distribute a supplemental water supply to 17,000 acres of land in Utah and Salt Lake Counties. The Weber-Provo diversion canal will be enlarged from its present capacity of 210 sec.-ft. to 1000 sec.-ft.

Eastern highway men meet in Boston

Officials from the North Atlantic states take up defense roads and other problems

Defense roads, traffic control, highway economics and maintenance and construction problems were discussed at the 17th annual meeting of the Association of Highway Officials of the North Atlantic States held in Boston, Feb. 19-21. About 1,500 members and guests were in attendance at the meetings and at the exhibit arranged by manufacturers of highway equipment and the highway departments.

H. E. Sargent, commissioner and chief engineer of the Vermont highway department, brought up the question of defense roads in his opening address as president of the association. He pointed to the failure of the federal government to provide funds to build access roads to serve military camps and industries engaged on defense contracts. He noted also that no funds other than regular federal-aid highway funds have been appropriated for the defense highway network, though the deficiencies of the network are very evident. Mr. Sargent said the states are ready to undertake such work and urged its early start in order to avoid wasteful haste at some later date.

The need for careful correlation of accident statistics with highway design was stressed by Arnold H. Vey of the New Jersey highway department, and Edward Copell, Massachusetts, and Prof. Maxwell Halsey of Yale discussed factors bearing on speed control.

Two aspects of highway modernization in Connecticut were reported by H. R. Turner and Harry Carsten. Connecticut is endeavoring to get the greatest possible value out of its old roads by underdraining and by using the old roads as stabilized bases for new surfacing.

What Pennsylvania is doing in snow removal was told by H. R. Moffitt. Snow removal costs on 18,215 miles averaged $240 in 1940 as compared to $217 for general maintenance. Snow removal cost $4,380,000 in that year.

Thomas G. Frame, chief engineer, Pennsylvania department of highways, was elected president of the association to succeed H. E. Sargent, commissioner and chief engineer of the Vermont highway department. E. Donald Sterner, highway commissioner of New Jersey, was elected vice-president, A. Lee Grover, Trenton, N. J., was re-elected secretary-treasurer, and A. W. Brandt, New York superintendent of public works, became an honorary director. Two new directors named were Herman A. MacDonald, Massachusetts commissioner of public works and David Noonan, assistant highway commissioner, New York.

First Okla. reclamation project approved

Construction of the Altus irrigation project in southwestern Oklahoma by the U. S. Bureau of Reclamation was approved Feb. 15 by Secretary of the Interior, Harold L. Ickes. The project will be the first undertaken by the Bureau of Reclamation in Oklahoma, where droughts of the 1930–40 decade contributed to a net decrease in the state population for the first time. Construction of the project will require four to five years.

The Altus project is located in Greer, Kiowa and Jackson counties, and when completed will store and deliver water for the irrigation of 70,000 acres of land. The project will also provide a supplemental municipal water supply for the city of Altus and control floods on the North Fork of the Canadian River through a reservoir of 200,000 acre-ft. capacity.

Estimated cost of the project, which was authorized by the Rivers and Harbors Act of 1938, is $5,600,000. Of this amount, the Lugert Dam and reservoir, including railroad and highway relocation, will cost $2,695,000. The main canal will cost $1,198,000 and the lateral and drainage systems, with miscellaneous items, $1,707,000. Of the estimated cost of the project, $3,080,000 is reimbursable. On March 29, 1940 an election held at Altus approved the formation of the Lugert-Altus Irrigation District to contract for the repayment of the reimbursable costs charged to irrigation.

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Mexico authorizes funds for transcontinental road

President Manuel Avila Camacho has authorized the governor of San Luis Potosi state to issue $1,450,000 in bonds to finance this year the construction of the state's section of the transcontinental highway between Tampico and the Pacific coast. The San Luis Potosi section will connect with the international highway between Mexico City and Laredo, Tex. Work is scheduled to start within 90 days.

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Highway for bombers at New Orleans

Construction of a double 28-ft. roadway with a 4-ft. dividing strip which, if needed could be eliminated to make a 60-ft. airplane runway, is now under way connecting the city of New Orleans to the local airport, which is one of the city's main highways. This road also will link the airport with army units being constructed on the lakefront.

JOBS OF THE WEEK

GENERATING, TRANSMISSION and DISTRIBUTION FACILITIES, Buffalo, N. Y.
Buffalo Niagara Electric Corp., Buffalo, will build extensions of generating, transmission and distribution facilities. Estimated cost is $5,000,000.

HOUSING, Seattle, Wash.
J. C. Boespflug, Seattle, Wash., awarded contract for constructing 690 unit low cost Yesler Hill housing project, at cost of $2,176,000, for Seattle Housing Authority, Seattle.

NORFORK DAM, Norfork, Ark.
Utah Construction Co., Ogden, Utah and Morrison-Knudsen Co., Boise, Idaho have received contract to construct Norfork Dam, in Norfork River from U.S. Engineers, Little Rock, Ark., at a cost of $10,778,726.

AMMUNITION DEPOT, Ravenna, Ohio
Hunkin-Conkey Construction Co., Cleveland, O., has been awarded contract to provide additional plant facilities and equipment for ammunition storage depot, by War Department, Washington. Cost estimated at $2,000,000. Atlas Powder Co., Wilmington, Del., will operate.

SYNTHETIC RUBBER PLANT, Houston, Tex.
C. F. Braun & Co., Alhambra, Calif., awarded contract for construction of plant for manufacture of butadiene, a basic ingredient of synthetic rubber for Shell Oil Co., Inc., of San Francisco. Total estimated cost is $3,000,000.

SHIP YARD EXPANSION, Oakland, Calif.
Navy Department, Washington, D. C., has awarded contract for construction of shipyard expansion to Moore Drydock Co., Oakland, Calif. Cost estimated at $4,000,000.

AVIATION FACILITIES, Bermuda
F. H. McGraw & Co., Hartford, Conn. and Purdy & Henderson Co., New York, N. Y., have received contract for constructing naval aviation facilities, from Bureau of Yards & Docks, Navy Department, Washington. Estimated cost $9,150,000.

AMMUNITION DEPOT, Talladega, Ala.
Dunn Construction Co., Birmingham, Ala. and John S. Hodgson, Montgomery, Ala., have been awarded contract to erect 500 reinforced concrete storage containers, at ammunition depot, by War Department, Washington, at a cost of $8,491,572.

HOTEL, Washington, D. C.
J. W. Harris Associates, Inc., New York, N. Y., have contract to erect hotel, for Statler Hotel Co., Chicago, Ill. Estimated cost $8,500,000.

SHIP YARD, Tampa, Fla.
Navy Department, Washington, has awarded contract for constructing first unit in ship-yard expansion to Tampa Shipbuilding Co. Estimated cost of the project is $1,000,000.

AIRPLANE PLANT, Hatboro, Pa.
Belmont Iron Works, Philadelphia, Pa., have contract to construct a 1-story, 600x600-ft. factory, for Brewster Aeronautical Corp., New York, N. Y. Estimated total cost $5,000,000.

ORDNANCE PROVING GROUND, Madison, Ind.
J. C. O'Connor & Sons, Inc., of Fort Wayne, Ind. and J. L. Simmons Co., Inc., Indianapolis, Ind., awarded contract for constructing an ordnance proving ground by War Department, Washington. Cost estimated at $4,183,770.

HOUSING, Columbia, S. C.
J. C. Heslep Co., Columbia, S. C., has contract to erect 350 residential units for non-commissioned officers at Fort Jackson, with water supply, sewerage, roads and landscaping. Contract awarded by Public Buildings Administration, Washington, at a cost of $1,059,000.

HOUSING, Long Branch, N. J.
Matthews Construction Co., of Princeton, N. J., has been awarded contract to construct a civilian housing project at Fort Monmouth, Long Branch, N. J., for Public Buildings Administration, Washington. Estimated cost is $1,662,500.

DIVERSION TUNNEL and COFFERDAM, New York, N. Y.
George M. Brewster & Son, Bogota, N. J., were lowest bidder for constructing a diversion tunnel, cofferdam, two exploratory caissons at Neversink Dam site in Sullivan County. Estimated cost is $3,406,895. Board of Water Supply, New York City, opened bids February 18.

SHIPYARD EXPANSION, Houghton, Wash.
Navy Department, Washington, D. C., awarded contract for shipyard expansion to Lake Washington Shipyards, Houghton, Wash., at cost of $700,000.

NOTE—Additional bidding and contract news on over 800 projects large and small appear in the Construction News section beginning on page 109.

OBITUARY

M. L. Hutton, state conservation director of Iowa since 1935, died Feb. 18, at Des Moines. For ten years he was with the Iowa highway commission. Mr. Hutton was a graduate civil engineer of Iowa State College.

Richard T. Sheahan, an assistant engineer on the staff of the New York City Board of Transportation, died Feb. 17, at the age of 66. Mr. Sheahan had recently been engaged in subway construction work in Brooklyn.

William H. MacMurray, member of the firm of Corbett & MacMurray, architects, New York City, died Feb. 20. Mr. MacMurray was a graduate engineer as well as an architect.

John T. Ryan of Pittsburgh, Pa., died Feb. 20, at the age of 57. He was vice-president and general manager of the Mine Safety Appliances Co. Mr. Ryan was associated with Thomas A. Edison in 1915 and assisted in perfecting the cap lamp for miners.

Roy Mullins, civil engineer with the New Jersey State Highway Department for 28 years, died Feb. 18, at the age of 56. Mr. Mullins was a graduate of Dartmouth College.

John H. Tait, civil engineer, 55, of the Arkansas State Highway Department, died Feb. 8 at Conway, Ark. Mr. Tait had been with the highway department for 13 years.

Charles H. Hornbeck, 59, a member of the South Dakota state highway commission since 1937, died Feb. 9, at Centerville, S. D.

James Wood Colt, a pioneer in railroad development in America and in Asia Minor, died Feb. 17 at Geneseo, N. Y., at the age of 83.

Alfred J. Cleary, 56, for nine years chief administrative officer of San Francisco, died Feb. 16. He was a graduate of the University of California in civil engineering class of 1906.

Warren G. Fowler, bridge engineer for Jackson county, Mo., 45, died at Kansas City, Feb. 13. Mr. Fowler was at one time Park Board engineer for St. Joseph, Mo., and a designing engineer for the Missouri Highway Commission.

Frank L. Dunlap, 53, chairman of the North Carolina State Highway and Public Works Commission, Raleigh, N. C., died Feb. 12. Mr. Dunlap had been on the highway commission since 1937.

Franklin Bolzinger of the U. S. Engineers died Feb. 12 at Grass Valley, Calif. He served with the 316th Engineers, 91st Division, in the World War. He was a graduate of Stanford University.

Harold S. Williams, structural engineer, with the firm of Battey & Childs, consulting engineers, Chicago, died at Oak Park, Ill., Feb. 12. He was 51 years of age.

Peter Tellin, 95, oldest retired engineer of the Sante Fe Railroad, died at Newton, Kan., Feb. 18.

Douglas Campbell Megginson, 43, civil engineer, died Feb. 17 at Gladstone, Va. He was employed by the C&O Railroad.

Charles T. Musgrave, 71, retired civil engineer, died Feb. 15 at Ogden, Utah.

Clarence Ross Cummings, 62, civil engineer, died Feb. 19, at Shortville, N. Y. Mr. Cummings was with the Lehigh Valley Railroad.

William J. Pace, pioneer civil engineer of western Canada, died Feb. 14.

CONTRACTS AND CAPITAL

Engineering construction awards for the week, $119,201,000, bring the 1941 total to $1,019,950,000 for the nine-week period. This cumulative figure tops the $462,905,000 reported for the corresponding 1940 period by 120 percent. Incidentally, it took 20 weeks in 1940 for engineering construction to reach the billion-dollar mark.

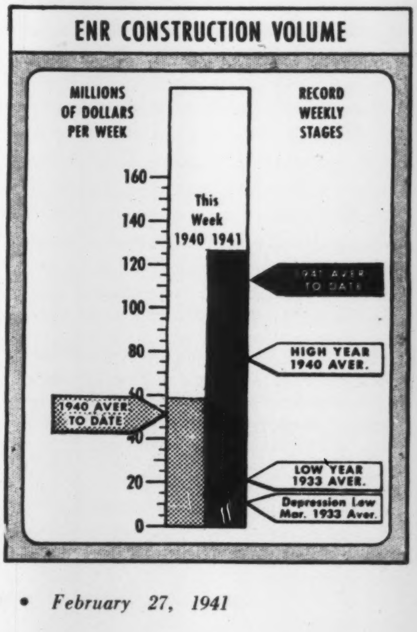
Both private and public awards participate in the increase over a year ago, private topping last year's total by 100 percent, and public, up 130 percent as a result of the 760 percent gain in federal work.

The week's construction total more than doubles the volume for the short week a year ago. This completes a full half year of gains for current awards over the values reported for their corresponding weeks a year ago. The volume, however, is 5 percent lower than last week due to a 12 percent decline in public construction. Private awards are 11 percent higher.

In the classified construction groups, gains over last week are in waterworks, earthwork and drainage, and streets and roads. Increases over the short 1940 week are in waterworks, sewerage, industrial, commercial and public buildings, earthwork and drainage, and unclassified construction.

New capital for construction purposes for the week, $25,278,000, is 115 percent above the total reported for the 1940 week. The current financing volume is made up of $12,250,000 in RFC loans for industrial plant construction, $6,572,000 in state and municipal bond sales, and $6,456,000 in corporate security issues.

New construction financing for the year to date, $679,111,000, is 285 percent higher than the $176,453,000 reported for the nine-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Feb. 29 1940	Feb. 20 1941	Feb. 27 1941
Federal	$8,714	$69,368	$51,025
State & Municipal	38,736	23,379	30,981
Total public...	$47,450	$92,747	$82,006
Total private...	11,644	33,366	37,195
TOTALS	$59,094	$126,113	$119,201

Cumulative
1941 ....(9 weeks)....$1,019,950
1940 ....(9 weeks).... $462,905

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1940 9 weeks	1941 9 weeks
NON-FEDERAL	$176,453	$170,111
Corp. Securities......	32,175	52,750
State & Mun.........	82,931	77,970
U.S.H.A. loans.......	60,786	13,521
R.F.C. loans.........	561	25,870
FEDERAL	....	$509,000
TOTAL CAPITAL	$176,453	$679,111

FHA MORTGAGES

	Week Ending Feb. 24 1940	Feb.15 1941	Feb. 22 1941
Selected for appraisal ...	$18,352	$22,919	$28,046

Cumulative
1941 ....(8 weeks).....$168,537*
1940 ....(8 weeks).....$134,386*

* Subject to revision.

ENR INDEX NUMBERS

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Building Cost	Feb. '41...	208.42	112.67
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Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Tacoma Bridge Investigation

Sir: Your issue of Jan. 23, 1941, contains an item relating to the Tacoma Narrows Bridge which is quite inaccurate in its referment to a third investigation under way by the insurance companies holding policies on the bridge wherein it states that Clifford E. Paine and Charles Evan Fowler are the engineers on this latter work."

The twenty-two insurance companies comprising all of the original insurers of the bridge created a committee known as the Narrows Bridge Loss Committee engaged me as their consulting engineer. The committee is empowered to investigate and report on the cause of the loss and the extent thereof. Mr. Fowler is not participating in this investigation and is in no way associated with me, as would appear from this news item.

CLIFFORD E. PAINE
Consulting Engineer
Chicago

Stay Systems for Suspension Bridges

Sir: Following its high traditions, *Engineering News-Record* has rendered an invaluable service to the profession in its prompt and exceptionally competent coverage of the engineering features of the failure of the Tacoma span and of the related subject of aerodynamic phenomena and remedial measures on other recent bridges.

My firm was glad to cooperate by making full information available for one of the articles in this symposium, "Two Recent Bridges Stabilized by Cable Stays" in your Dec. 5 issue. We have always followed the policy of making all data and information of interest to the profession promptly and freely available. Lest any contrary impression be produced by the recent date of publication, permit me to record the fact here that the aerodynamic phenomena observed on the two Thousand Islands suspension bridges and the remedial measures applied were promptly reported to the profession by the writer over two years ago in an article, "Construction of the Thousand Islands Bridge" in *Civil Engineering,* November, 1938, and in a prior illustrated paper on "The Design and Construction of the Thousand Islands Bridge" before the structural division at the fall meeting of the Am. Soc. C. E. at Rochester, Oct. 12, 1938. Thus this information was made available to bridge engineers in ample time to be utilized on the Whitestone and Tacoma spans.

In your companion article "Stays and Brakes Check Oscillation of Whitestone Bridge" (Dec. 5 issue), the following statement appears: "The diagonal stays were adopted as a supplementary device after elaborate tests on a model conducted at Princeton University by Prof. E. K. Timby for the Triborough Bridge Authority. The tests showed that such stays will check oscillations effectively; of several alternative arrangements of stays the adopted one was concluded to be best." This statement may produce the impression that the Whitestone system of stays was adopted in preference to the Thousand Islands system of stays on the basis of comparative tests at Princeton. I have good reasons to believe that the Thousand Islands system of stays, although it had proved successfully effective on three suspension bridges of 750, 800, and 1,080 ft. spans, was not included in the Princeton tests for the Triborough Bridge Authority.

In order to elicit open discussion, I submit the following list of reasons why I believe that the system of end-stays adopted for the Whitestone Bridge is less efficient and effective than the system previously successfully applied on the Thousand Islands and Deer Isle bridges:

1. Lack of automatic temperature compensation. The stays will tend to be slack in summer and overstressed in winter, requiring continual attention and adjustment. If the stays are permitted to become slack due to temperature change, they will be largely inoperative until substantial oscillation of the bridge has developed.
2. The stays connect to the tops of flexible towers which participate in the motions the stays are intended to check.
3. The side-span stays connect to points in the side spans which further participate in the main-span and tower motions which the stays are intended to check. When the main-span point of attachment moves downward, the adjacent side-span point of attachment moves upward a greater amount, rendering the system of stays slack and ineffective.
4. This system of stays helps to bring main span, towers, and side-spans into unified harmonic motion, instead of checking such motion.
5. This system of stays directly helps to bring the torsional flexibility of the towers into play with any tendency of the two sides of the span to get out of phase in their undulations. The stays thus help to build up a twisting undulation, instead of checking it.
6. A single stay at each corner is more likely to have a natural period fitting into the harmonics of the span than a multiple system of stays each adjusted for a different period.
7. The point of attachment of a single stay, acting as a node, is more likely to fit into one of the natural wave patterns of the undulating span than the separated points of attachment of a multiple system of stays.
8. The concentration of tension in a single stay, instead of a multiple system of stays, tends to increase local distortion of the cable and stiffening girders.
9. Since the stays are more nearly parallel than normal to the cable, they will tend to act with it rather than against it, reducing their effectiveness in checking harmonic undulations in which the cables are the controlling factor.

D. B. STEINMAN
Consulting Engineer
New York, N. Y.

Sir: It must be clear that such general unqualified assertions as are made in the above letter are valueless unless they are substantiated by most careful analysis, and in this case by intricate experimental research.

Some time ago Dr. Steinman made unsuccessful attempts to sell to the Triborough Bridge Authority his services and the use of his patented stay ropes which he endeavors to advertise as being superior to anything else. This may explain the motives behind his criticism of the Whitestone Bridge installation.

The following explanations will answer Dr. Steinman's assertions Nos. 1 and 8: The stresses in the stiffening girders caused by the stays are within permissible limits. The stays are to receive an initial stress of 220,000 lbs., which is sufficient so that under high temperature combined with improbable live load they would not get slack. This condition was tested in the model. The maximum design stress in the stays, at low temperature, inclusive of the initial stress, is less than half the ultimate strength of the ropes. The stays have fixed connections at both ends which cannot give or slip and need no adjustment. The assertion that they "get slack in summer and overstressed in winter, requiring continual attention and adjustment" has therefore no foundation whatsoever.

As regards the other assertions, all of which refer to the effect of the stays on the dynamic behavior of the bridge, they involve such a complex problem that no one, not even the most learned physicist, could make a reliable analysis without experimental investigation. Dr. Steinman's medley of arguments is pure guesswork expressed in impressive sounding scientific words. The only answer to these arguments is that extensive studies of various arrangements of stays made on the model of the bridge proved that one stay on each side of each tower is at least as effective as a group of two or three. Mention should be made that friction devices installed for some time on the bridge at the ends of the center span, and also tested on the model, have proven effective in damping oscillations and that the diagonal stay ropes are being installed in addition thereto.

Stays of Dr. Steinman's patented type were compared with the adopted ones, but were found not to be worthy of testing in the model for the following valid reasons:

Calculations of deflections of the bridge with and without stays showed that the Steinman patented type of stays would not decrease the deflections to the same extent as the adopted type of stays. The reason for this can readily be recognized in their smaller inclination. From all evidences this fact justified the conclusion that they would not be as effective.

The most serious objection to the Steinman patented type of stays lies in their connections to the cables. The cable bands, to which these stays would have to be connected, were at the time of erection required to be tightened by a stress in the bolts of 40,000 lb. per sq.in. The ten $1\frac{3}{4}$-in. bolts which hold one cable band could therefore exert a maximum theoretical pressure of 960,000 lb. on the cable. Actually the compound pressure of ten bolts may be much less and the wide fluctuation of an eccentrically applied force from the stays under constantly changing live load, temperature and wind conditions would have been bound to loosen the cable bands in course of time. Under such conditions safe design would certainly not permit the maximum force acting on the cable band parallel to the cable to exceed 15 percent of the theoretical maximum cable band pressure, or 144,000 lb. The initial tension in the stays as required to prevent reversal of stress and slackening of the stays, would alone exceed that safe limit and, together with maximum live load and temperature stresses, not considering those from wind, would bring the total force component acting on the band parallel to the cable to over 500,000 lb. or more than three times the safe frictional resistance.

It would be of interest to know whether the Steinman patented stays applied to the two Thousand Island Bridges and in the Deer Isle Bridge are under all conditions safe against cable slipping. From the figures applying to the Whitestone Bridge there is every reason to believe that the connections call for constant watching.

O. H. Ammann
Chief Engineer
Triborough Bridge Authority

Air Raid Damage in London

Sir: In reply to your inquiry I venture to give some comments on my recent experience with air raid damage in London as follows:

(1) Normal brick buildings, particularly those erected some considerable time ago, show very little resistance to blast, not to speak of direct hits. Their stability, under normal conditions, is due to deadweight only and they can not resist horizontal forces greater than wind. Exposed to blast from high explosive bombs, brickwork is liable to disintegrate; floors and ceilings are left without support and the result is the total collapse of the building. This is how the considerable amount of damage is to be explained over rows of houses of this type cause by a single bomb.

(2) Brickwork in 1: 3 cement mortar shows itself considerably superior. Surface shelters with $13\frac{1}{2}$-in. brick walls in cement mortar can be seen more or less intact even with bomb craters near by. In some cases, the reinforced concrete roof, between 5 and 8 in. thick, has separated from the supporting brick walls, the latter being blown inwards or outwards by blast or suction. With improved designs of surface shelters this has been avoided.

(3) Steel structures of the old type were not able to resist any appreciable amount of blast, owing to the fact that connections between roofs, walls and ceilings rely mostly on a few bolts or rivets, quite insufficient to transmit horizontal forces from blast. We can frequently see steel columns and roof trusses standing or hanging in the air separated from each other. This could be avoided by providing strong joints between individual parts so as to secure rigid frame action against lateral forces.

(4) Framed structures in steel or reinforced concrete are actually those types of buildings which withstood bomb effects in an excellent way. You can see them in many parts of London badly damaged by direct hits, but with the structural damage localized through the rigidity of the framework. Bombs striking such structures at an angle often penetrate through the side walls exploding inside and blowing out portions of the walls but leaving the main supporting frames more or less intact so that rebuilding can be started without delay.

(5) As to deformation of steel under blast and impacts, it is interesting to see that, even under direct hit, steel members were considerably deformed before failure. This can be noticed in plate girders of bridges and in roof trusses of all types when the steel members are bent and twisted under impact. Except with old cast iron floorbeams, which could be expected to break like glass, I have not come across any brittle fracture of structural steel members similar to those I saw after the collapse of the Hasselt bridge in March, 1938. (In *ENR*, Aug. 18, 1938). This fact, I think, testifies to the high qualities of structural steel used in this country, and particularly to its capacity to resist impact.

In conclusion it is significant that well-designed engineering structures, particularly those of framed types, have shown a great amount of resistance under air raids. Modern architecture of prewar times, as far as it included large areas of glazing, was or course, helpless against bomb effects. On the other hand modern tendencies in structural engineering design have been confirmed and encouraged by experience in air raids.

O. Bondy
Consulting Structural Engineer
London

EDITORIALS

VOLUME 126 NUMBER 9

February 27, 1941

Boom Town Blues

MUNICIPAL OFFICIALS in rapidly expanding boom towns have the blues. Totally unprepared in most cases to cope with population increases of 100 percent and more, the villages and towns affected by industrial and training camp activities are in a tight spot. There are exceptions of course, such as Fayetteville, N. C., a boom town whose activities are described elsewhere in this issue, but for the most part the cities have neither the financial resources nor the administrative machinery to provide new streets, utility facilities and other services so desperately needed. Some consolation can be had from President Roosevelt's special message to the Congress on Monday, in which he enunciated federal responsibility in furnishing financial aid for public works in boom towns. The $150,000,000 that is requested for this purpose will be of decided help in alleviating community "growing pains," and quite logically is justified as a national defense expense item.

Credit for a Good Job

PRAISE for its part in the national defense program, which was given the Associated General Contractors by high-ranking military and defense officials at the Houston convention last week, emphasizes the important position A.G.C. occupies in the construction industry. Existence of this organization of the nation's leading general contractors enabled government officials to mass construction power quickly and get started on vital projects so necessary to other defense measures. There have been no bottlenecks in construction, and the industry stands ready to carry on in the same swift, efficient manner as demonstrated in providing housing for a million troops in two months' actual working time. Though defense construction is the biggest job of the A.G.C. at the moment, it has not overlooked the problems of contractors not engaged in such work. The association now has the respect of government, labor and industry, and is qualified to represent and lead the general contracting fraternity. Managing Director Foreman, his capable staff and the competent A.G.C. officers, as well as all the members, merit the praise that the nation's defense leaders chose to turn their way.

Never the Same Thing Twice

BRIDGE ERECTION has probably been more productive of new ideas than any other type of construction, since differences of local conditions and variations in design of structures give a completely new set of problems on every project. Outstanding even in this classification is the erection of the Ludlow Ferry Bridge over the Potomac River below Washington. First, balanced cantilever erection of the main span was assisted by an ingenious closing truss extension to the anchor pier, which substantially reduced erection stresses and hazards. Then, for the approach spans of Wichert type, a steel falsework truss was floated from span to span and lowered to a temporary seat on the bridge pier where it supported the steelwork until the span was closed. For one span, which was not too high off the water, erection was carried out on a car float, after which the span was lowered to pin connection points over the piers, a ticklish operation. It is this constant selection and trial of new methods and different schemes that permits extension of design to more economical and ever larger structures.

Bearing Walls Indicted

AMONG the many instructive papers presented at the American Concrete Institute convention last week, two were specially significant. These related to a half-dozen housing projects in Chicago, Newark and Atlantic City for which frame construction was adopted in preference to that using exterior bearing walls. The significance lies in the evidence that time and money were saved and that wall cracking was avoided. By using wall columns, concreting could be carried on without waiting for an exterior wall support to be built; this contributed to speed and, in turn, saved money. By allowing concreting work to be completed ahead of wall enclosure, forms could be removed easily instead of having to be taken out through windows or down stairways; this also saved money. By supporting floors on the frame instead of on the walls, slab curling as a cause of wall cracking was eliminated. These advantages were gained at the expenditure of extra design energy and expense, but this is, of course, the essence of good engineering, particularly since the added design expenses were less than the savings made in the field. The evidence from these jobs as presented by their designers points to an indictment of bearing-wall buildings. At least for the moment the burden of proof is on the proponents of the bearing-wall type of construction.

Federal Road Policy

PROPOSED MODIFICATIONS of federal road policy to adapt it to national defense needs contained in the Public Roads Administration's report to the President (*ENR* Feb. 20, p. 289) call for wide support. They are realistic without going to the extremes that some have urged. But when it comes to asking for funds to put the policies into effect the PRA report clearly reflects the administration view that roads, except those serving camps and war industries, are not an essential part of the defense program.

The report proposes that the federal government bear all the cost of access roads to military reservations and to new war industries, also that it pay the cost of repairing roads used for army maneuvers. These of course are proper federal responsibilities.

For roads of the strategic highway network whose improvement will provide local benefit the report recommends federal participation "on a somewhat higher basis than the existing 50-50 basis." This is a logical compromise from the costly and politically dangerous scheme of putting the cost of all work on the strategic network on the federal government.

In its proposals for specific appropriations the report is not so praiseworthy. In the first place, it asks but $150,000,000 for access roads to camps and war industries while estimating that roads to the camps alone will cost $220,000,000. True, some normal federal-aid funds and some WPA funds are being used for these camp access roads, but they hardly appear adequate.

Only $100,000,000 is asked for aid to the states in building needed sections of the strategic highway network. This does not square with the billions that are being spent to build a great mechanized army to protect this country against invasion.

The report goes a long way toward giving the nation a logical defense road program. It falls short in providing for the strategic network if there is any intention of using, or even of training, our mechanized army in this country.

Be Fair, Be Sensible!

IF CONGRESS decides to investigate the Army's procedure in awarding fixed-fee construction contracts, a course which was under consideration last week, the members of the investigating committee should give careful and honest consideration to one very important question before they call any witnesses. That question is whether it is against the public interest for a civilian consultant to the Army to be connected with a firm that is given a defense construction contract. One such consultant who faced the House Military Affairs Committee last week was treated with raised eyebrows at the hearing and a group of sensational headlines in the next day's newspapers. Since not the slightest evidence of malpractice was disclosed, such treatment is patently unfair.

And not only is it unfair to the individual, it is lacking in sense with respect to the national defense program. Where but to outstanding engineering and construction firms is the Army to turn for the best consultants? Once it has obtained the services of these men, is it to rule that the firms with which they were connected are ineligible for Army construction contracts? Is it sensible thus to penalize the defense program by denying the country the use of many of its most efficient organizations? And as for the consultants being on the federal payroll at the same time that they share in the profits of their firm, does not the federal pay, if any, that they receive, just about cover their expenses in Washington?

Since such consultants do not participate in decisions affecting their own firms, they are, so far as we can see, serving their country honestly, unselfishly and patriotically. Congress could serve in the same way if it would acknowledge that there is nothing wrong *per se* in the Army's use of consultants from firms that may hold defense contracts; indeed that such procedure may be for the nation's best interest. After that it could go as far as it liked in exercising its unquestioned right to probe for dishonesty and inefficiency.

NGINEERING NEWS-RECORD

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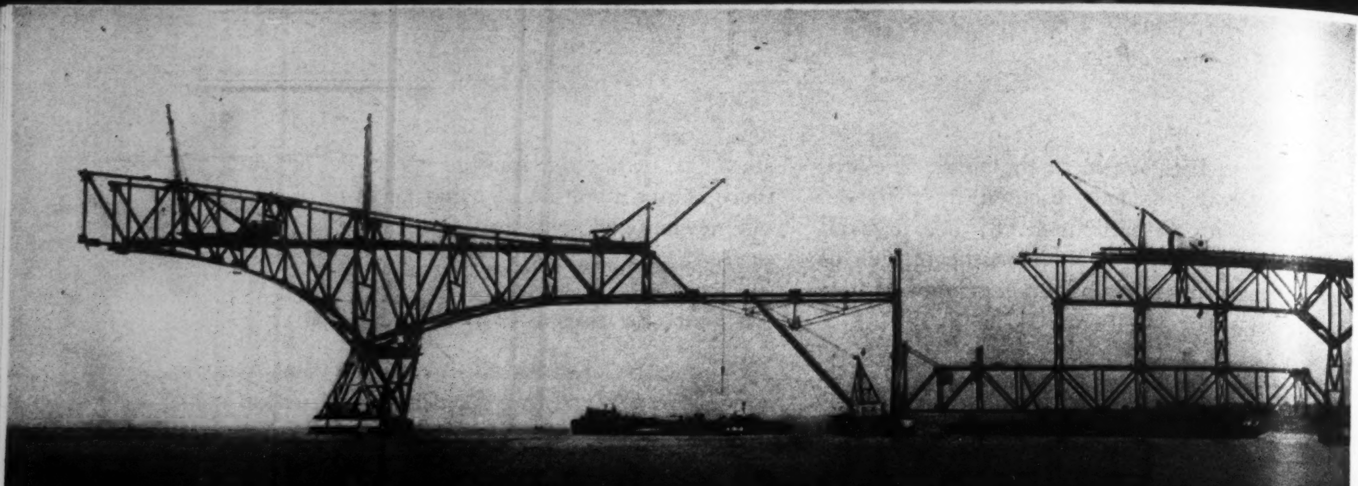


Floating Falsework for Bridge Erection

***Contents in Brief**—The 10,000-ft.-long superstructure of the Ludlow Ferry Bridge, which crosses the Potomac River 50 miles below Washington, includes a curved chord cantilever main channel span, 10 truss spans and 12 girder spans of Wichert type, and 60 simple girder spans. The cantilever was erected by balancing about the main piers in conventional manner except that the anchor spans, when about half completed, were joined to the anchor piers by temporary steel to reduce balancing and wind stresses. All but the last of the Wichert truss spans were erected over a temporary truss support that was floated in and set on the piers; the last span was floated in and lowered to position without the use of falsework. Girder spans over water were lifted into place by floating derricks while those over land were set by crawler cranes. The unusual pile-supported caissons used in the substructure of this bridge were described in* ENR, *Feb. 29, 1940, p. 306.*

Few Bridges have been built in which such a variety of erection methods were used as on the new crossing of the Potomac River between Ludlow Ferry, Md., and Dahlgren, Va., some 50 miles below Washington, D. C. Particularly notable was the wide use of floating equipment and falsework, but land cranes, deck travelers and guy derricks were also effectively utilized. The erection work was distinguished further by the fact that it marked the first occasion upon which a Wichert truss span was preassembled and floated into place; the pinned rhomboid-shaped end panels of such trusses are a special complication in this method of erection.

The Ludlow Ferry Bridge is 10,050 ft. long between abutments. The main channel crossing, near the center of the structure, consists of an 800-ft. curved chord cantilever span that provides 140-ft. shipping clearance and two 367-ft. anchor spans. Between the cantilever and the shore on the Virginia side are 6 Wichert truss deck spans (2 of 350 ft. and 4 of 276 ft.), 6 Wichert girder spans (2 of 117 ft. and 4 of 162 ft.) and 60 simple girder spans of about 61.5 ft. each. On the Maryland side there are 4 Wichert truss deck spans (2 of 350 ft. and 2 of 276 ft.) and 6 Wichert girders (2 of 117 ft. and 4 of 162 ft.).

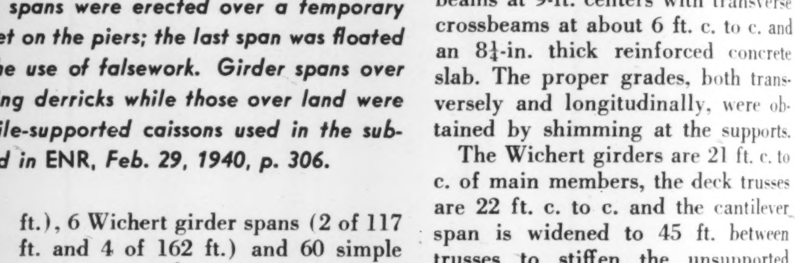
General layout of the structure provides a pair of girders or trusses supporting floorbeams which in turn carry three lines of longitudinal stringers. These carry, at about 5-ft. centers, transverse crossbeams cambered to the crown of the roadway. The transverse crossbeams support the deck which is composed of grid pattern steel floor with light gage metal pan bottoms. This grid flooring is filled with concrete to a depth of ¾ in. over the 4¼-in. depth of the steel grid giving a total depth of floor of 5 in. The steel grid was not used for the 61.5-ft. beam spans. Here the deck system consists of three lines of beams at 9-ft. centers with transverse crossbeams at about 6 ft. c. to c. and an 8¼-in. thick reinforced concrete slab. The proper grades, both transversely and longitudinally, were obtained by shimming at the supports.

The Wichert girders are 21 ft. c. to c. of main members, the deck trusses are 22 ft. c. to c. and the cantilever span is widened to 45 ft. between trusses to stiffen the unsupported 800-ft. length.

The roadway width is 24 ft. between curbs, with an emergency footwalk 1½ ft. wide on both sides of the bridge. The steel plate comprising the walkway and curb is an integral combination non-slip and plain steel plate with plain portion rolled down to form the curb.

Erection procedure

Steel for the bridge was fabricated at New Market, N. J., and moved by rail to a point near the site, or when



A 276-ft. span was erected afloat and lowered to pier caps. Next span on right was erected as cantilever without falsework.

Balanced cantilever erection of the channel span was made possible by use of a jacking bent on the wide pier. Erection hazards were reduced through the use of a 136-ft. preassembled queen-post truss, which included the bottom chord members of the bridge, used to close the four panels of the anchor arm. Wichert truss spans were erected over the top chord of a falsework truss, floated into position and then set on the pier caps. Adjustable single leg bents provided proper elevation.

Stewart Bros. Photo

time and weather conditions permitted to a terminal at Philadelphia, for transhipment by barge to point of use. No rail service is available directly at the bridge so all steel—except the girders on the Maryland side, which were trucked from rail siding to point of use—had to be delivered to final position by water.

Erection of the structure was forced into various schemes by limitations of accessibility. The simple beam spans on the Virginia end of the project are at low level over sufficient water for floating equipment so they were set entirely by floating derricks which were fended from the pile bents by temporary piling. The Wichert deck girder spans of the Maryland approach being overland were set with two long boom crawler cranes lifting each assembled girder member. A temporary vertical post, equipped with adjusting jack, divided the rhomboid end panels into two rigid triangles during erection.

Erection over the water of the Wichert deck spans and the long cantilever was more difficult. Solid material at the site is from 100 to 145 ft. below the surface of the water, making pile falsework unduly expensive. The broad expanse of water left the site open to frequent severe squalls which might cause serious movement of any floating equipment. The spans are so high above the water that floating them in already assembled on barges, especially with rhomboid end panels was dangerous if not impractical. The final decision therefore was to erect the cantilever by balancing operations and to float in falsework trusses, set them on the piers and erect the Wichert truss spans overhead.

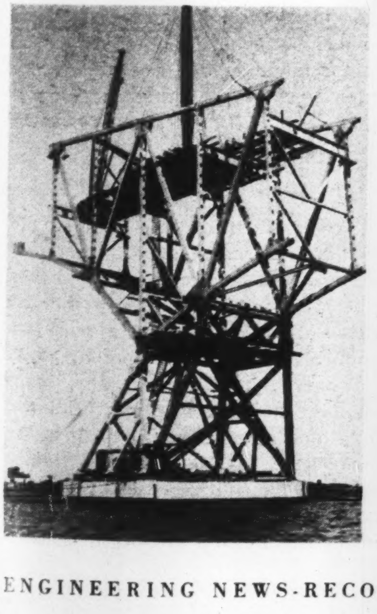
A floating derrick erected the steel framework which supports the trusses at varying heights above the piers. At the cantilever span piers and two other points these supports are triangular towers of considerable height set on pier caps supported by caissons at the four corners of a 49-ft.-wide pier. Two floating rigs erected the deck girder spans over the water.

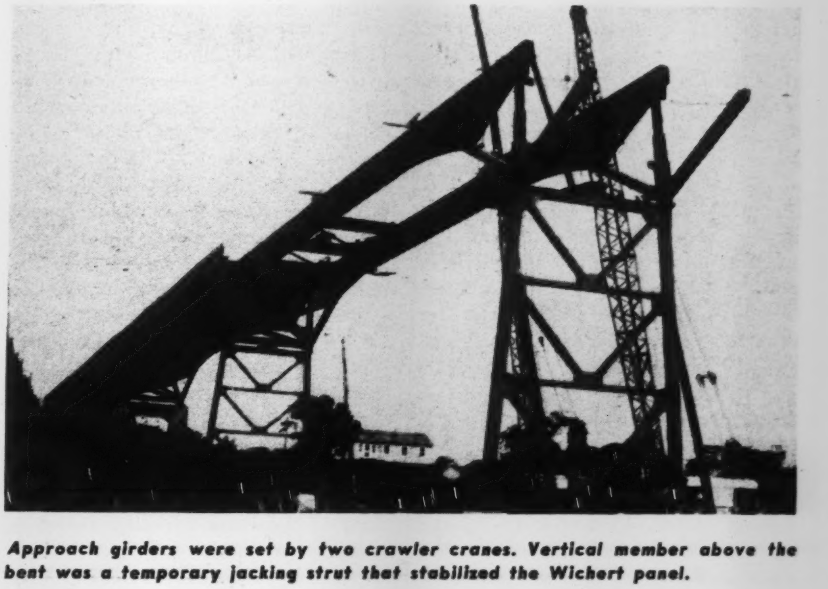
Balanced cantilever erection

The channel cantilever span and the adjacent anchor spans were erected by the balanced cantilever method as shown in the accompanying illustration. A temporary bent from the base of the tower to the first panel point from the tower in the anchor span, also erected by the floating derrick, took the balancing load of variable compression and tension stresses. A 300-ton jack, built into the bent, under each truss was used to adjust the elevations of the anchor arm for closure. A guy derrick set up on the pier, with the aid of the floating rig, was used to start the main span erection. After one panel of steel was erected the guy derrick was jumped up to the roadway level and was then used to complete 1½ panels on either side of the tower. At this point two traveling derricks were set up by the guy derrick and were then used to carry on the erection. Close balance was maintained by means of a strain gage extensometer which was set up to indicate the amount and direction of stress in the temporary bent. Erection procedure could then have been varied to meet necessity but no change from the original plan was indicated.

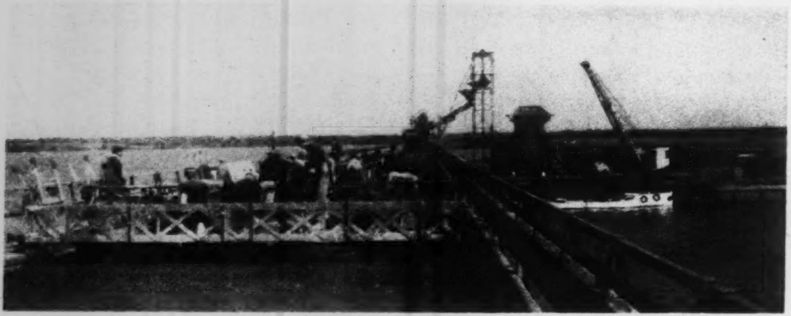
As the balanced cantilever erection moved farther from the pier, danger of damage from sudden squalls on the broad expanse of open water increased. When the anchor span reached four panels from the steel supporting bents on the anchor piers, a temporary truss, using the bottom chords of the last four panels as the top chord of an inverted subdivided

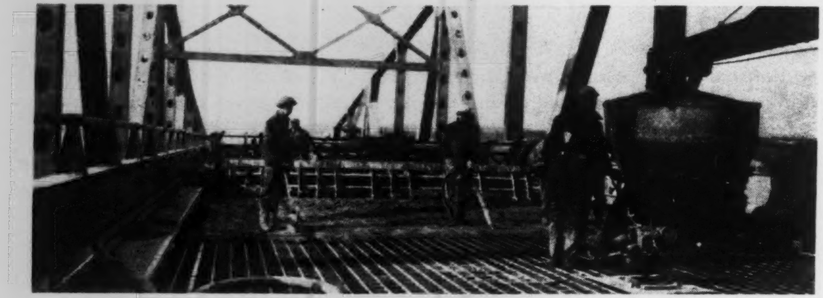
Jacking leg supported cantilever and provided adjustment for closure.





Approach girders were set by two crawler cranes. Vertical member above the bent was a temporary jacking strut that stabilized the Wichert panel.





Floating plant (above) supplied concrete for pumping to low level beam spans through a tower hoist. Special vibration equipment (below), pushed ahead of the finisher, insured filling the steel grid completely with paver-mixed concrete. The flexible shaft vibrator was seldom used here.

king-post truss was assembled on a barge deck and the 136-ft. length raised into position by the erection traveler and a floating derrick. Then the members to complete the truss were set using ⅞-in. bolts at connection points in half of the 1-in. holes to allow play for vertical movement of anchor arm.

Closure of the anchor span was effected by raising or lowering the tower jacking leg until individual holes in each affected member were aligned to take drift pins and bolts in all the holes. After all members were connected the jacking leg at the main pier was removed and its connections burned off.

The center 400 ft. of the 800-ft. central span of the cantilever is designed as a suspended span but for erection was framed as a rigid portion of the cantilever and one-half erected with each arm. Final closure, near the center of the 800-ft. span, was made by use of two 300-ton jacks per truss in U17-18 on each side of the center of the main span and in L16-17 on one side only.

Wichert truss erection

Most of the Wichert spans of the structure are located high above the water and, as the use of falsework was precluded, presented unusual difficulties in erection. Floating them into position was not considered safe as the falsework would be so high that rocking or mismovement of a barge might damage the span. A simple truss bridge was designed with spans adjustable to the varying openings between the piers. This required "erector sets" capable of easy adjustment for length as pier caps varied from 7 to 49 ft. in width and truss spans were 275 or 350 ft. long. This truss was built on a barge, largely of members of the permanent structure, and floated into position at an elevation such that the outgoing tide lowered the truss onto prepared supports on the pier caps. (The small tide range made it desirable to use jacks and pumps to expedite and control the vertical movement.) A 3.75-percent grade over the bridge required provision for varying the elevation of the tops of the falsework, accomplished by setting single-legged steel towers at the panel point and inserting hydraulic jacks to provide exact elevation and closure adjustment. Erection proceeded in one direction only, a single traveler on the deck of the truss handling the erection except on the first span, which was set by floating derrick. A temporary jacking leg was inserted in the truss over each pier to stabilize the rhomboid shape during erection.

Original erection plan was to float in the last three truss spans, one of 350-ft. length, but fall weather conditions were encountered with frequent wind squalls so the plan was altered, one of the spans being erected over the falsework truss which had been floated in.

Truss erected afloat

Next, and for what is believed to be the first time in this country, a Wichert truss span, 275 ft. long, with rhomboid end panel, was erected on a car float on falsework, then lowered to the bridge seats. This scheme was used to avoid the expense of a steel falsework truss as most of the members of the previously used erection span were from this portion of the work and the vertical clearance was small for an economical truss. The section was assembled entirely free of the permanent supports or connecting steel as tide and wind movement on the barge and structure made this impossible. The floating section was connected without incident, though there were anxious moments as the joints approached the pin-connection position. Several jacks and pumps were used to adjust the level of the truss span, by lightening or loading to supplement the tides, to bring the joints to pin alignment.

The 350 ft., between the 275-ft. spans, was then erected by cantilevering out equally from each adjacent span to connection in the center. Closure was effected by means of a temporary jacking post set vertically in the rhomboid and which was capable of jacking against both tension and compression loads. For this cantilever erection a floating derrick was used instead of the traveler to reduce erection stresses.

Variety in deck paving

Accommodating the paving to available working space during steel erection the deck contractor worked wherever possible to finish the job ahead of winter. Aggregates most economically reached the site by water so concrete for the low beam spans on the Maryland side was produced by a floating mixing plant which was made up of a 1-yd. mixer set under a 75-ton bin and serviced by a crane on the same barge. Concrete from the mixer was hoisted in 1-yd. buckets to the top of a 46-ft. tower and from there chuted to a double cylinder concrete pump. The pump, working from two set-ups and pumping 900 ft. each way from each setup, placed all the concrete for the open deck system of the sixty 61.5-ft. beam spans. Average rate of placing was about 190 yd., or 308 lin. ft., per day.

A finisher spanned the full width of the deck, operating on the rolled curb rail which was carefully shimmed to a grade that would give smooth riding after addition of the concrete deck weight.

For the deck of the main structure an I-beam grid system with light metal pan bottom forms was used. Concrete was batched from a bin set up on the deck of a barge, grounded for convenience at the bridge site on the Maryland side. Two-batch trucks hauled from this plant to a paver on the bridge deck. Planks over the deck made a runway for the paver, the pneumatic-tired trucks operating directly on the 6-in. grid pattern steel.

Paving was started about midway of the total length on the high structure and proceeded toward the Maryland approach using high-early-strength cement the last days in this section so that there would be a minimum of delay in hauling to pave the remaining section after the rest of the steel structure was completed.

Personnel

The bridge was built as a toll project of the State of Maryland. The J. E. Greiner Co. of Baltimore designed the structure and have supervised its construction through W. H. Pahl, project engineer, and Raymond Archibald, resident engineer. Merritt-Chapman & Scott Corp., New York, put in the foundation.

Harris Structural Steel Co. of New York fabricated and erected the superstructure. R. H. Smith was field superintendent and Ed Geuber field engineer. Methods and details of erection were worked out by H. Kendall, chief engineer, F. Swertz, erection engineer, and E. Adamec, assistant erection engineer, who also served temporarily as field engineer. Geo. S. Richardson of Pittsburgh was consulting engineer on erection.

The deck paving was done by Duffy Const. Co. of New York City. F. F. Duffy, president, was in general charge of the work with John Norrgard, superintendent and H. A. Mix, engineer.

Exposed Interior Concrete Used For High Class Apartment House

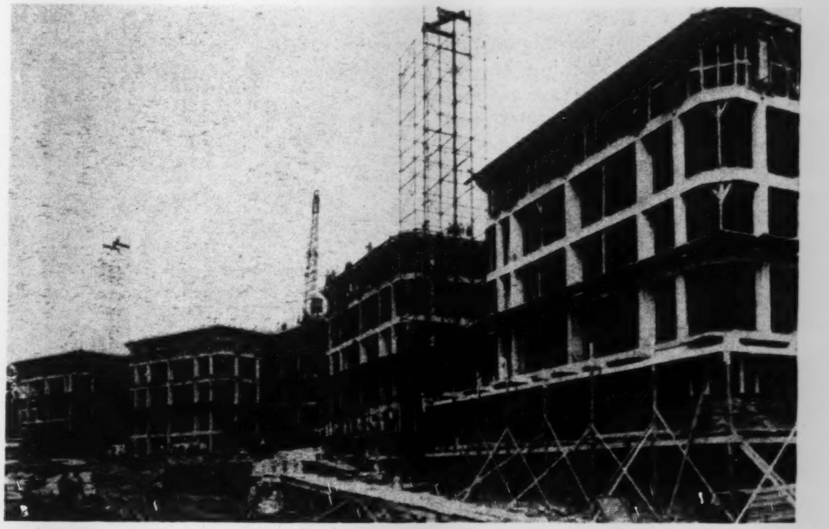
Contents in Brief*—Use of form lining or plywood have made exposed concrete suitable for residential interiors. Its use has generally been confined to low-cost housing but for a private apartment project at Montclair, N. J., renting at $35 per room per month, the concrete subcontractor finished and painted this type of surface to a high degree of perfection. Exterior walls are two courses of brick with an air space between.*

THE COLUMNS, beams and underside of the floor slab are left exposed in an apartment building recently completed in an exclusive residential area of Montclair, N. J., an expedient heretofore used only in low rent and subsidized buildings. The responsibility for securing a satisfactory surface was placed wholly on the concrete subcontractor by the requirement that he finish and paint the concrete, resulting in conservatively designed and accurately built forms and careful placing of concrete. The building has a complete concrete frame with concrete slab floors varying from 4 to 5 in. Double walls with a 2¼-in. space characterize the brick construction (*ENR*, Sept. 12, 1940, p. 332). This wall design is relatively common in England, under the name of "cavity wall," but is new in American practice.

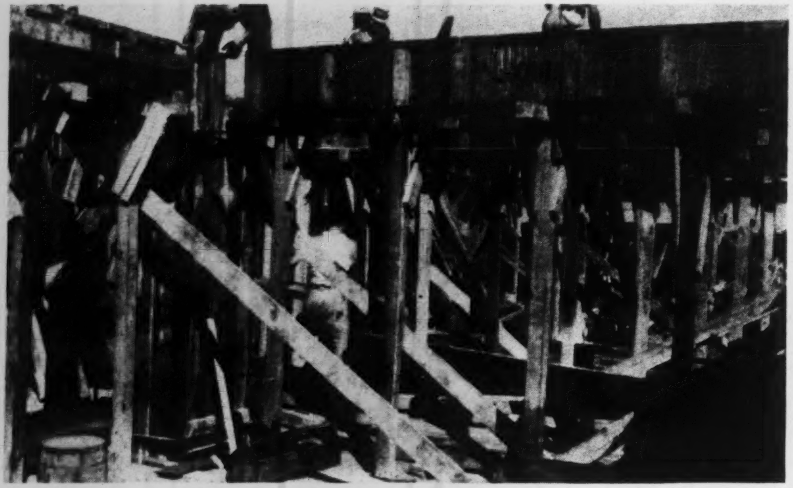
The floor plan is irregular to give a maximum of air and light but all floors are identical. Columns of uniform size are maintained for the full height of the building by using 3,000-lb. concrete for the three lower stories and 2,500-lb. concrete for the upper frame. The walls do not carry any structural load, exterior concrete columns being provided, to facilitate rapid construction free from the delay, expense, and confusion of laying up brick walls along with the concrete construction.

Speed requirements dictated a complete set of forms for one full floor, comprising 24,000 sq.ft. of surface, and permitting seven uses of the material. The building is divided transversely by one construction joint, construction and concreting breaking at this point as each half required about 350 yd. of concrete. The transverse joint assisted in scheduling the construction work as the forms at one end of the building were moved while reinforcing and concrete were placed at the opposite end, thus providing continuous work for all trades.

Column forms were fabricated in a job shop and all pieces plainly



Well-built forms and careful placing permitted leaving interior concrete exposed despite floor-a-week progress with one set of forms.

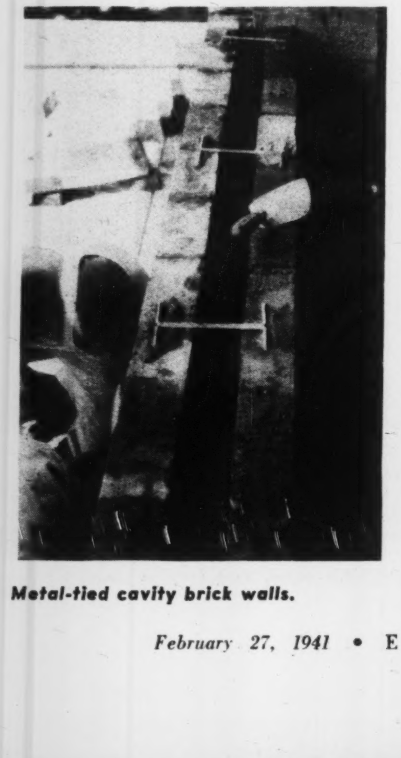


Marking instead of cutting brings economy to forms for apartment where all floors and columns are identical.

marked even to the side of column on which they were to be used, to eliminate errors and speed form erection. Column forms were of $\frac{5}{8}$-in. douglas-fir plywood, with 1x5-in. rough spruce laid flat serving as stiffeners; conventional steel column clamps held the form square and tight. Beams are all the same depth, 18 in., from top of slab to bottom, but form locations were carefully marked to maintain the same position on each floor as slab depths, and hence beam sides as well as lengths between columns differ. Deck forms were $\frac{5}{8}$-in. douglas fir plywood supported on 3x4 loose pieces at 19-in. centers, cut and marked for use in a specific bay.

Concrete was purchased delivered at the site by truck mixers. Trucks delivered into a hopper used to feed a 1-yd. bottom-dump bucket, hoisted to a portable buggy feeding hopper by a crawler crane. Average placing time for half of a floor section was 7 hr. for the 350 cu.yd. Concrete aggregate used was $\frac{3}{4}$-in. max. size crushed stone and the mix provided a medium slump. Bottom course reinforcing was laid directly on the forms and carefully raised up into the fresh concrete with hooked rods thus preventing even bar chairs being exposed in the finished ceiling. One man worked ahead of the concrete cleaning all debris, especially wires and nails, from the forms to assure a surface free from blemishes. Two flexible-shaft vibrators were used to secure complete compaction and avoid honeycomb in the concrete. Particular attention was given to securing a perfect finish on the concrete as the contractor recognized that the practical and economical time to get a good surface is on the plastic concrete.

Dictated by necessity for speed, column forms were stripped the morning after the pour was made and other forms stripped after a full 24 hours when high-early-strength cement was used and in two days with standard cement. As stripping proceeded, replacement shores were set and wedged snug under the centers of beams and in the middle of large slab areas. Shores were held until the next three floors above were complete. Forms were handed up through the elevator openings and stair wells for use on the next floor.



Metal-tied cavity brick walls.

Concrete was left exposed for ceilings, beamsides and columns in all rooms except the bath where a hung plaster ceiling conceals piping. Only minor rubbing of concrete has been required to condition it for painting. Sixteen finishers without mechanical equipment prepared two floors, 48,000 sq.ft. per week. A very critical eye detects the markings of the joints of the plywood and some of the minor irregularities through one coat of paint but the second coat almost completely smooths up the concrete making it fully as good as the more conventional plaster.

After experiment with paints for covering concrete, white casein was selected for the first coat and slightly tinted white casein for the second. Both coats are brushed on.

Double brick walls

For insulation and added dampproofing qualities the walls are two courses of brick separated by a $2\frac{1}{4}$-in. air space which is kept entirely free of mortar. At each spandrel waterproofing is introduced and the inner course of brick rests on an angle bolted to the concrete frame. At each vertical column the outer wall is tied with special $\frac{1}{4}$-in. galvanized double L inserts. The two walls are tied together at each fifth course and third brick with special inserts as shown.

The building is divided into 16 three and one-half to seven-room apartments on each floor with all rooms "outside" and many of them with cross-ventilation. Interior walls are of cinder block, plastered and painted, and coincide with the beams of the frame. Heating is by steam following conventional design. Floors except the kitchen and bath are hardwood laid on a troweled mastic over the concrete slab.

Personnel

Rockcliffe Apartments were built by R. M. C. Construction Co., New York, general contractor with William Palfrey in charge. All concrete work from forms to final painting is handled by the Industrial Engineering Co., New York, under direction of M. L. Hauck, Superintendent. Victor Mayper of New York is structural engineer and the firm of Sugarman & Berger, also of New York, architects for Winston Paul, owner.

Geared for Boom Town Growth

Edward J. Cleary
Associate Editor, Engineering News-Record

Contents in Brief*—Adjacent to Fort Bragg, N. C., where 66,000 troops will be stationed, is Fayetteville. Like many another community affected by national defense activities, Fayetteville should be having severe growing pains. It is growing, but the pains are not yet felt, thanks to foresight.*

AMONG THE MOST PROMISING of the "boom towns" that are being vitalized by national defense activities is Fayetteville, N. C. Only nine miles from Fort Bragg, where a civilian army of construction workers 12,000 strong is building accommodations for 66,000 troops, this substantial little city is remarkably well organized to expand without too much trouble. This is particularly true in regard to its public works facilities.

The term "boom town", with its connotation of madhouse growth and superficiality, is a misnomer when applied to Fayetteville. The fact is that planning for the boom of 1941 might be traced back almost 200 years when a colony of Scotchmen "laid out" the village in this upper Cape Fear River region. Uncanny vision at that time led to the establishment of a number of streets 100 ft. in width. This means that four lanes of traffic now can be accommodated and diagonal parking permitted on both sides of the principal thoroughfares in the town.

Located at the eastern border of the sand hills section of North Carolina, Fayetteville is at the head of navigation on the Cape Fear River, 115 miles northwest of Wilmington. Named in honor of General LaFayette, it was the capital of the state until 1791. Primarily it is an agricultural city, although it does have some textile and lumber industries. Travelers using U. S. Highways No. 15-A and 301 on their way to and from Florida undoubtedly will remember how they circled "Ye Olde Market House," a venerable structure standing at the intersection of the principal streets in the city.

Foresight and efficient management of public business have paced the steady growth of Fayetteville which jumped its population from 9,000 in 1920 to over 18,000 in 1939. For example, as far back as 1906, water, sewer and electric services were placed under the direction of a non-partisan public works commission, the present manager of which has held his post for 21 years. And to insure expansion and development consistent with present and future needs the city adopted a zoning ordinance back in 1925, not many years after the principles of zoning had been formulated in this country.

Hay Street, main thoroughfare of Fayetteville, has a 100-ft. width, because of foresight shown 200 years ago when the village was laid out.

Thus, with an adequate street pattern established, a zoning ordinance in good working order, and a public works organization efficiently operated, Fayetteville is peculiarly well adapted to take advantage of the boom which has come its way. In fact, in some ways it is a step or two ahead of the boom and thus better able to capitalize on the growth and prosperity ahead.

At this early stage of the boom it is somewhat difficult to evaluate just what it will mean. But here is one yardstick. City engineer W. W. Baker says that in the last six months building permits (mostly residential) have averaged about $175,000 a month, as compared with a yearly total of $271,000 in 1936, $381,200 in 1937, and $509,905 in 1938.

The money coming into Fayetteville from payrolls at Fort Bragg cannot be calculated with any accuracy. But the sum must be large. Construction workers alone, many of whom are housed in the city, receive a daily wage of $50,000. The regular army, as of November when 21,000 troops were in camp, was paying out $750,000 a month; in June, 1941 this monthly payroll is expected to total approximately $3,000,000.

To meet immediate needs in public works construction, the city is asking its citizens to vote a bond issue of $590,000. About half of this money will go for water, sewer and electric distribution improvements, and the balance will be used for streets and fire houses. All of this is in addition to work already complete or under way, notably a new high school costing $145,000 and a $150,000 city hall which will be finished in March.

The Public Works Commission

The Public Works Commission, with 34 years' experience in providing water, sewer and electric power services, is taking boom demands in its stride. Because of consistent city growth in the past, it has been customary for the commission to plan improvements five or six years in advance. Consequently, in order to meet present demands it was only necessary to advance these plans for immediate execution.

Water filter plant capacity is 3 mgd., although the present demand is only 2 mgd. In the near future plant capacity will be increased to 5 mgd. In the meantime work will be started on a 1-mgd. elevated storage tank, the installation of a 300-hp. diesel engine for standby pumping power and strengthening of the grid distribution system by means of interconnections.

New water mains in housing subdivisions are not installed by the Public Works Commission. However, the subdivider must construct these facilities in accordance with plans and specifications issued by the commission. The commission then reserves the right to buy this pipeline, when and if it is to its advantage to hold physical ownership. The price to be paid is determined when the pipeline is installed, based on an examination of the subdivider's labor and material costs; the contract between the commission and subdivider, stating the agreed price, is signed upon completion of the work, and this contract is filed until the time of purchase.

J. L. Weathers, manager of the Public Works Commission. Water, sewers, electric service and public buildings have been his responsibility for 21 years

Pipelines in subdivisions are bought only when they are to be incorporated into the grid system and interconnected to insure better distribution and pressure. This has proved to be an economical procedure.

Sanitary sewers are installed by the commission, but the cost of this facility is not charged against the property as an assessment. Instead, the commission has a standard sewer rent which is charged to every householder; this amounts to 35 cents a month and is put on the same bill containing charges for water and electric service. In view of the fact that this sewer rental plan has been used for almost 30 years in Fayetteville, this community can lay claim to being one of the first to finance and maintain a sewerage system on the basis of a service charge.

The commission owns and operates the electric distribution system, buying its power wholesale from a private utility. However, for the first twelve years of its existence the commission did operate a municipal generating plant.

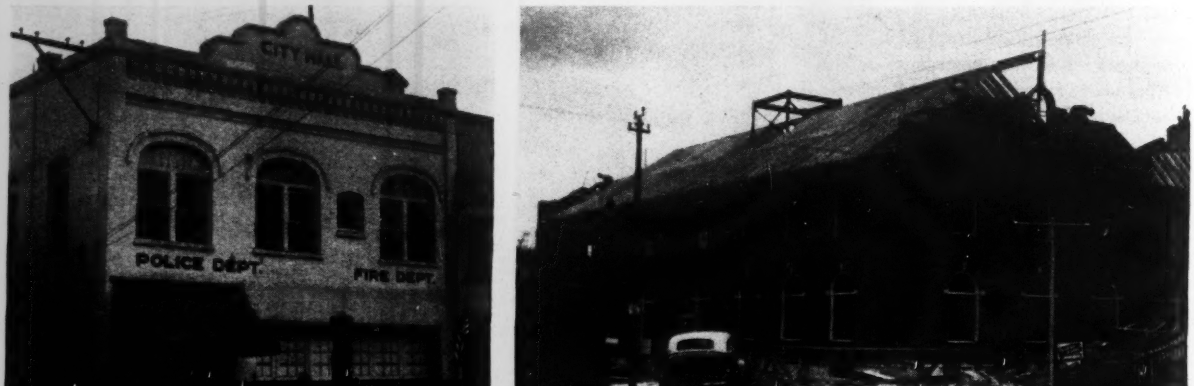
One index of efficient public works administration in Fayetteville can be gathered from the statement of J. L. Weathers, manager of the commission, who said:

"Each year the commission has turned over a substantial sum to the general fund of the city, in addition to paying off retirement on its own bonds, as well as operating and maintenance costs on plant. Last year, for instance, the commission paid $190,000 cash to the city and retired $46,000 worth of obligations."

Mr. Weathers was particularly proud to point out that the commission pays all of its bills within a week after they are received, thus saving substantial sums as well as establishing an excellent credit reputation.

Although the population of Fayetteville is only 18,000, the Public Works Commission has been serving the metropolitan area which includes some 30,000 people. To provide these services the commission owns plant structures and equipment which are valued at $6,000,000.

Foresight, fortuitous circumstances and smoothly operating municipal machinery that can operate at high speed, are making it easy for Fayetteville to adapt itself to the fast tempo of defense preparations. Here is one community that is geared for boom town growth.



Good enough in its day, but now a new city hall is being rushed to completion to meet the increased needs of expanding public business in Fayetteville. In many ways the city is a step ahead of the boom.

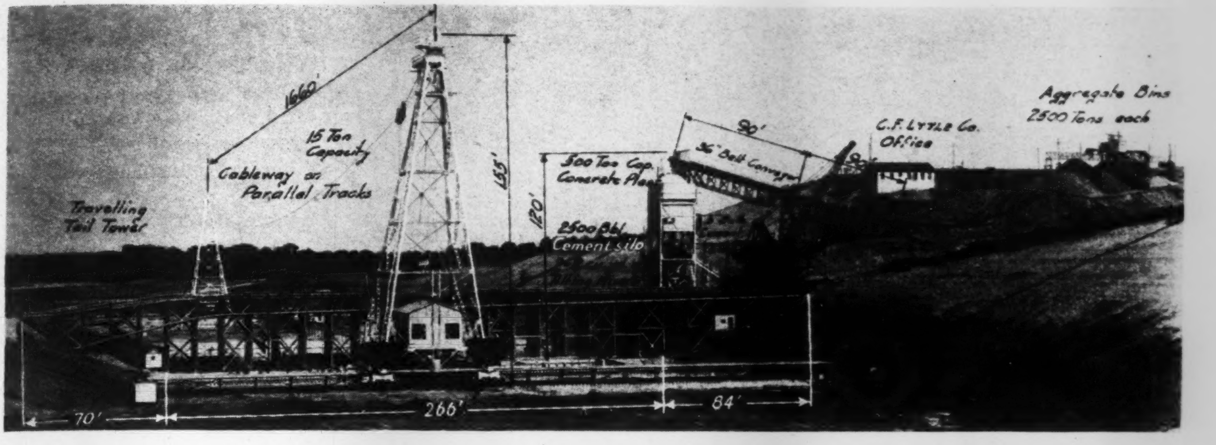


Fig. 1. Construction plant layout from aggregate storage to cableway for concrete placing.

Plant for Denison Dam Outlet Works

E. G. Wernentin

Chief Engineer, C. F. Lytle Co.
Sioux City, Iowa

***Contents in Brief**—Construction of the outlet works at Denison Dam, on the Red River between Oklahoma and Texas, required an unusual type of concrete plant. To cover an area 256 ft. wide and 1,632 ft. long, the contractor installed a 1,660-ft. traveling cableway, served by shuttle trains loaded at a central plant and operating over a trestle. Steel penstock liners are fabricated on the job.*

JUST AS the outlet works for Denison Dam are unusual in character, the construction plant built by C. F. Lytle Co., Sioux City, Iowa, for the prosecution of their $3,870,000 contract for the project, is most unusual for work of this type. The outlet structure, containing 236,000 cu. yd. of concrete, is spread over an area 256x1,632 ft. Specification requirements for construction procedure, especially as to pouring of alternate concrete monoliths, necessitated a highly flexible concrete plant. To meet these requirements over the wide area covered by the outlet works, the contractor installed a traveling cableway with a span of 1,660 ft., to handle concrete buckets delivered by a shuttle train running on a trestle from a central plant. The central plant is charged by belt conveyor from stockpiles located high on the side of the valley. A big revolving gantry crane also operates on the shuttle trestle, handling the heavy penstock lining sections (fabricated on the job) gate sections and machinery, and concrete for the intake structure.

Gate-controlled conduits

Denison Dam, being built by the U. S. Engineer Department as a flood control and power project, is located on the Red River, between Oklahoma and Texas, near Denison, Tex. It will be the largest rolled-fill dam in the world, containing 22,000,000 cu. yd. of material.

The outlet works consist of four sections, listed in order from upstream to down: (1) approach channel; (2) intake and gate structure; (3) conduit section, including a transition from the intake; and (4) stilling basin. The approach channel, 232 ft. long, is flanked by concrete retaining walls, and is paved for the lower 50 ft. next to the intake.

The intake structure, containing 46,000 cu. yd. of concrete, is 256 ft. wide, 76 ft. long and 130 ft. high, and is made up of 1,500 individual monoliths. In the interior of the structure are 16 service gates and 16 emergency gate wells in which 12 service gates and 2 emergency gates are to be installed. These gates are of the "caterpillar" type, each having four sets of tractor rollers, and weigh 24 tons completely assembled. The service gates will be operated by individual hoists mounted on the operating deck above each gate, and the emergency gates will be handled by a 120-ton gantry crane which will ride on rails in the operating deck.

The conduit section, including a transition between intake and conduit, contains 150,000 cu. yd. of concrete. It is a block of concrete 256 ft. wide, 28 ft. high and 800 ft. long, incasing eight 20-ft-dia. circular conduits, of which three are to be used as sluiceways for flood control, left unlined, and five are to be penstocks for the power plant. The latter are lined with $\frac{1}{2}$-in. steel plate, reinforced with 10-in. wide-flange beams, 3 ft. $5\frac{3}{4}$ in. c. to c. These steel liners, received at the job in segments forming 120 deg. of arc, or three to a complete ring, 10 ft. 5 in. long, are fabricated in the field to form full rings of the same length. In the fabrication process they are hung on monorail carriers to permit

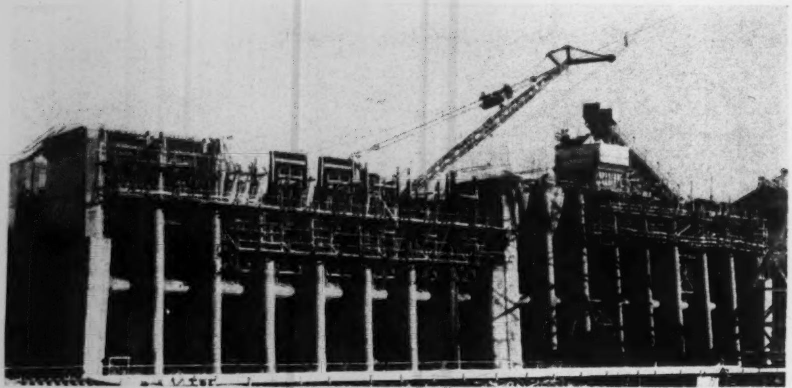


Fig. 2. *Intake structure rises upstream from the construction trestle, which carries a revolving gantry crane for placing the concrete shown here and handles the big steel penstock sections.*

rotating the rings, which greatly simplifies the shop work. All exterior faces are thoroughly blasted with steel grits, after which one coat of bituminous primer and two coats of bituminous enamel are applied to the blasted surfaces.

The rings, weighing 11 tons each, are then transported by the cableway to their final location in the field, where they are completely assembled into continuous conduits. Specifications require that alternate monoliths be completed around the conduit liners before any concrete in adjacent monoliths can be placed, and that at least one circumferential joint in the conduits in these adjacent blocks be left loose until all concrete has been placed in alternate monoliths.

The stilling basin, located immediately downstream from the three flood control conduits, is 206 ft. wide, 530 ft. long and has a deep section 18 ft. below top of the Goodland limestone rock level. The basin contains 40,000 cu. yd. of concrete. Excavation for the basin goes through the limestone, 15 ft. thick, through a Walnut clay formation below the limestone and into the Trinity sand formation.

Construction plant

The concrete plant starts with an aggregate storage on a side of the valley. Two sizes of crushed stone, unloaded from hopper bottom cars, and sand, unloaded from end dump trucks, fall into a track hopper and are fed by a 30-in. feeder belt to a 36-in. belt conveyor, thence to a 24-in. shuttle conveyor which distributes the material into three stockpiles of 2,500 tons capacity each. From these stockpiles the materials are fed by double clam gates to a second 36-in. belt conveyor located in a tunnel beneath the stockpiles, which carries the aggregate to the concrete plant. Here they are distributed to their respective bins by means of a turnhead and chute.

Bulk cement is unloaded from boxcars by wheeled scoops into a cement conveyor, and is conveyed by compressed air to a 2,500-barrel silo adjacent to the concrete plant. From the silo a screw conveyor and bucket elevator raise the cement to the plant cement bin.

The concrete plant, of 500 tons capacity, is located just outside the finished structure. It is carried on a steel substructure 40 ft. high, the foundations for which are on Goodland limestone. This Goodland limestone is also the foundation for all concrete in the structures. The height of substructure and the plant is 120 ft., and top of plant is at an elevation just 10 ft. below that at which the aggregates are unloaded from cars and trucks. The plant, fully automatic, is equipped with weigh batchers and electrically-controlled charging mechanism. It contains two 2-cu. yd. tilting mixers, electrically driven and tilted by air which requires a tilting pressure of 100 lb. per sq. in. and a cushion and return pressure of 50 lb. per sq. in.

From the plant the concrete is carried to buckets of both 2 and 4-yd. capacity, in a 4-yd. shuttle car operating over a trestle, which occupies the area of the transition between intake and conduit. As this section of concrete will be placed late in the construction period it offered a very desirable location for the trestle, with the concrete plant located 10 ft. south of the south wall of the structure and in line with the east half of the trestle. This trestle is 40 ft. high, 32 ft. wide and 420 ft. long. It is also designed to carry the gantry, a 25-ton tractor gate and a 4-yd. shuttle car of concrete at any common location.

The cableway buckets are landed on a shelf downstream from the trestle and at an elevation low enough to permit gravity discharge from car to bucket.

The cableway

The cableway, with a span between towers of 1,660 ft. and with towers 155 ft. high, is built on parallel tracks, each 350 ft. long, on which both towers travel. In this manner the entire area occupied by the structures can be covered by the cableway, and form setting, reinforcing bar handling, concrete placing and steel conduit liner setting can be carried on continuously without delay, which would not be possible with other types of equipment that could not be operated over fresh concrete and would thus be limited in fields of operation.

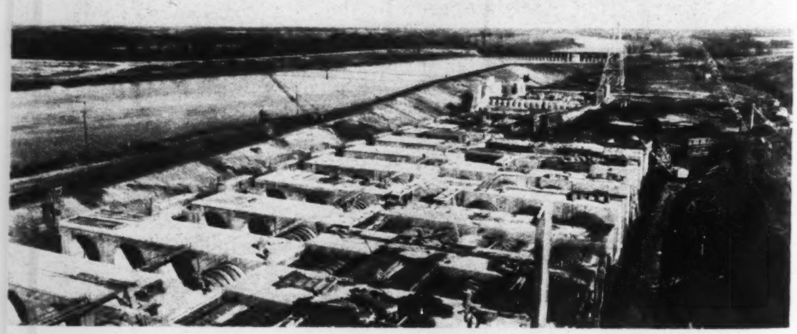


Fig. 3. *Downstream view of the conduit area from tops of the tail and head towers of the cableway system. The cableway placed all of the concrete shown in this view and also set all of the steel penstock sections.*

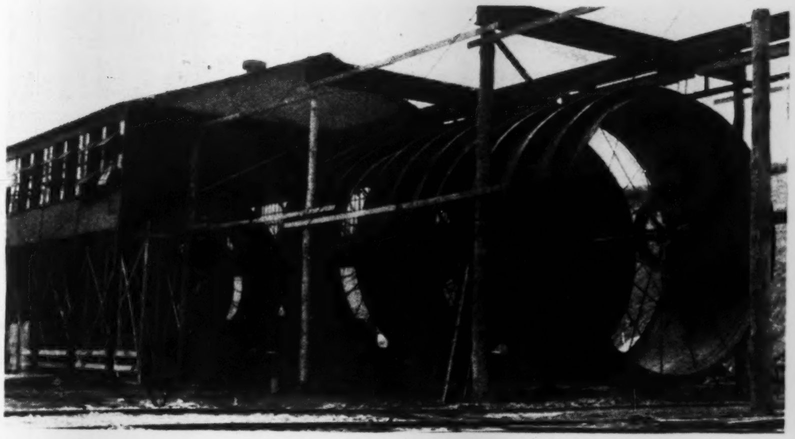


Fig. 4. Fabrication of the steel penstock sections. Each section, 10½ ft. long, is made up of three 120-deg. curved plates and three 10-in. stiffening rings.

The cableway, with a live load capacity of 15 tons, is equipped with an electric drive main hoist of 300 hp., and each tower is moved by two 25-hp. motors geared to the driving trucks. Controls for the traveling motors are so arranged that normally the two towers move in unison; however, one tower can be moved independently of the other if desired.

Unusual counterweights

An interesting and unusual feature of the cableway is the type of counterweight used. On the head tower the counterweight consists of two stacks of scrap railroad rail, each weighing 125 tons, cross-piled around each of the back legs of the tower. For the tail tower the counterweight consists of 250 tons of scrap railroad car wheels stacked symmetrically on two 36-in. girder beams, resting on box girder sections riveted to the back legs of the tower. The use of this scrap material made the counterweight system very economical and the placing and removal cost also made this counterweighting method more desirable than any other.

Compressed air for the job is supplied by a battery of four compressors, three 800-cu. ft. capacity and one 250 cu. ft. at 120-lb. pressure. Water for all job use, except drinking, is pumped by one 5-in. and one 6-in. deep well pump from 16-in. perforated casings in excellent water bearing gravel to a concrete lined reservoir of 650,000-gal. capacity located on a hill about 130 ft. above the foundation level. From this reservoir the water flows by gravity to all parts of the job and to the concrete plant. Drinking water is obtained from the Denison city water system through a 4-in. main.

A 12,000-v. power line delivers electrical energy to the job substation, at which point it is stepped down to 440 v. to drive all equipment except crawler cranes.

Two 40x100-ft. portable steel mill buildings house the tool room, the compressors, machine shop, electrical shop and warehouse. A 60x60-ft. carpenter shop and covered platform complete the contractor's plant.

From the wide-flung locations in which various parts of the contractor's plant and equipment have been obtained, the job organization has come to refer to it as the "All American Plant." The Pacific Northwest, the Carolinas, California, Massachusetts and states in between, all have contributed to some part of the setup, and the job takes pride in the fact that these "All American" parts have been assembled into a very smooth and highly efficient plant.

Direction

The Denison Dam project is under the direction of the U. S. Engineer District Office at Denison, Texas. Capt. Gordon E. Textor is the district engineer, and J. B. Alexander is principal engineer.

For the C. F. Lytle Co., R. F. McCune is general superintendent; E. G. Wernentin is chief engineer; F. M. Case, office manager; Al Johnson, F. C. Muir and C. R. James are assistant superintendents.

The Chicago Bridge & Iron Co. is fabricating and erecting the steel conduit liners, and the Wailes Dove-Hermiston Corp. is grit blasting and painting the liners. The Omaha Steel Works, Omaha, Neb., is fabricating the gates, guides and hoists. General excavation for the outlet works, amounting to 3,500,000 cu.yd., was carried out under a separate contract by Condon-Kerns Co., Omaha, Neb.

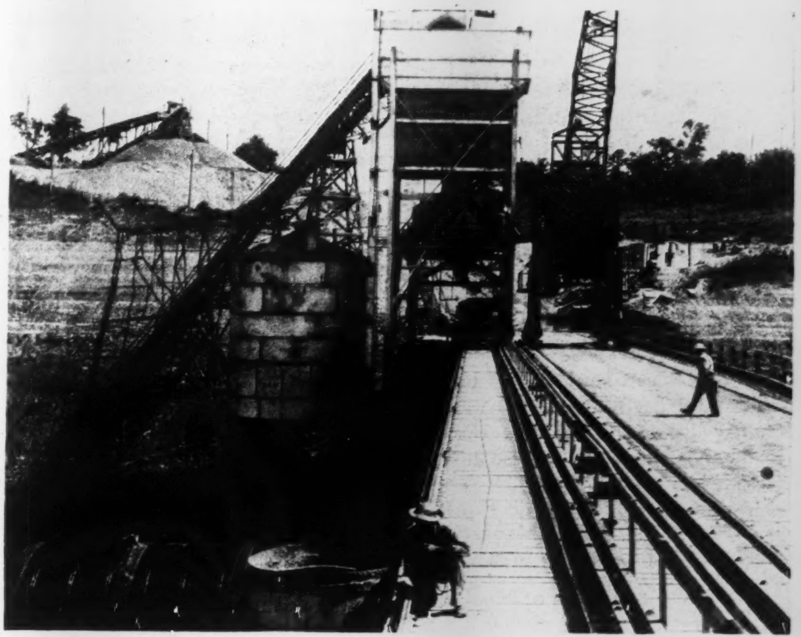


Fig. 5. All concrete and steel for the outlet works are moved over this trestle, located in the transition area between intake and conduits. Leading out from the mixing plant is the shuttle track for delivery of concrete to the cableway buckets.

Balancing Head Losses in a Pipe Network

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and

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***Contents in Brief**—This is a modified application of the Hardy Cross method of computing the flow distribution and variation of head in various parts of a pipe network. The authors devised this procedure as a means of reducing the required numerical work in the balancing operation.*

THIS ANALYSIS represents a modification of the Hardy Cross method for computation of head loss in a pipe network which, it is believed, will decrease the amount of numerical work otherwise required. The simplification of this method suggested by Prof. G. M. Fair in an article in *Engineering News-Record* (March 3, 1938, p. 342), will be employed and the same problem which he presented will be used here to show the advantages of the authors' suggestions.

In order more successfully to balance the head losses around each circuit after one trial has been made, the Cross method requires, as Fair has shown, that a change in flow in each circuit should be made which may be computed by the formula

$$\Delta Q = \frac{\Sigma h}{1.85\ \Sigma h/Q} \qquad (1)$$

Here ΔQ, designated by Prof. Fair as simply Δ, is the change in flow to be made in each pipe of a given circuit. $\Sigma\ h$ is the algebraic sum of the head losses of all the pipes in the circuit, the so-called unbalanced head loss, and $\Sigma h/Q$ is the sum of the quotients of the head losses and their respective flows for all the individual pipes in the circuit. The number 1.85 (represented by n) in this formula is the exponent of velocity in an expression for head loss based upon the Hazen-Williams formula.

Now the change in the head loss of each pipe in the circuit which results from this change in Q is approximately $1.85\frac{h}{Q}\Delta Q$ as will now be shown:

Here h and Q are the original estimates of head loss and of flow in the pipe under consideration.

Since $h = KQ^{1.85}$, then

$$h + \Delta h = K(Q + \Delta Q)^{1.85} =$$

$$= KQ^{1.85} + K(1.85Q^{.85})\,\Delta Q + \left[K\frac{1.85 \times .85Q^{-.15}}{2}(\Delta Q)^2\right] + \text{etc.}$$

or by subtracting h which equals $KQ^{1.85}$,

$$\Delta h = 1.85\,KQ^{.85}\Delta Q + [K(.786Q^{-.15})(\Delta Q)^2] + \text{etc.}$$

$$= 1.85\frac{h}{Q}\Delta Q + h\,(.786)\,(\Delta Q/Q)^2 + \text{etc.} \qquad (2)$$

Omitting all but the first term to the right of equation (2), it appears that the change in each head loss term is equal to $1.85\ \frac{h}{Q}\ \Delta Q$. Substituting the value of ΔQ from equation (1) into this expression it follows that,

$$\Delta h = \frac{h}{Q} \times \frac{\Sigma h}{\Sigma h/Q} \qquad (3)$$

Furthermore, the second term on the right of equation (2), which equation (3) neglects, will be no more than one percent of h if $\Delta Q/Q$ is no more than 11 percent, or if $\frac{\Sigma h}{\Sigma h/Q}$ is no more than 21 percent of Q. Hence it appears that when the head losses in a circuit become so well balanced that subsequent changes in Q in the pipes in which the larger head losses occur amount to no more than 10 percent, or when the value of $\frac{\Sigma h}{\Sigma h/Q}$ is no more than 20 percent of their Q's, then subsequent adjustments may be made to the individual head losses directly. Thus it is possible to avoid the burdensome task of looking up head losses from tables for the remaining portion of the balancing operation.

Illustrative example

This method is illustrated in the example shown in Fig. 1, the computations for which are given in the accompanying table. The complete description of the several pipes is given in the first few columns of the table.

It is to be noted in the computations that the head loss tables have been used but twice. The final results are in close agreement with those given by Fair. The authors have chosen original assumptions for Q which are much farther from correct than Fair's original assumptions in order to show the adaptability of their method. It was found that Fair's original assumptions were so nearly correct, that when the authors' method was used no changes in Q had to be computed but only Δh, and thus the head loss tables were

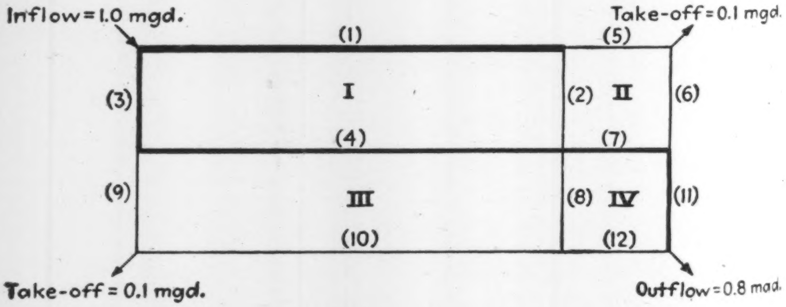


Fig. 1. Pipe network chosen for the computation of flow distribution and variation in head using a modified application of the Hardy Cross method. Computations are given in table.

CALCULATIONS OF SUCCESSIVE APPROXIMATIONS USED FOR THE ANALYSIS OF FLOW DISTRIBUTION IN THE NETWORK SHOWN IN FIG. 1.

Circuit	Pipe No.	Length in 1,000 ft.	Diam. in inches	C	Assumed Q_0 in mgd.	S_0 in ft. per 1,000 ft. from tables	h_0 in ft.	$\frac{h_0}{Q_0}$	ΔQ_0	Q_1	S_1 from tables	h_1	$\frac{h_1}{Q_1}$	n ΔQ	Δh	n ΔQ	Δh	n ΔQ	Δh	n ΔQ	Δh	n ΔQ	Δh	Σn ΔQ	Σ ΔQ	Σ Δh	Q	h	Fair's values for h
I	1	2.0	12	120	+.7	.77	+1.54	2.20	−.122	+.578	.54	+1.08	1.87	+.020	+.04	−.021	−.04	+.006	+.01	−.005	−.01	+.002	.00	+.002	+.001	.00	+.579	+1.08	+1.08
	2	0.5	6	120	+.4	8.00	+4.00	10.00	−.122−.020	+.258	3.56	+1.78	6.90	+.020+.061	+.56	−.021−.008	−.20	+.006+.007	+.09	−.005−.002	−.05	+.002+.002	+.03	+.062	+.034	+.43	+.292	+2.21	+2.21
	3	0.5	8	100	−.3	1.62	−.81	2.70	−.122	−.422	3.08	−1.54	3.65	+.020	+.07	−.021	−.08	+.006	+.02	−.005	−.02	+.002	+.01	+.002	+.001	.00	−.421	−1.54	−1.54
	4	2.0	8	100	−.1	.21	−.42	4.20	−.122+.008	−.214	.87	−1.74	8.14	+.020+.002	+.18	−.021−.008	−.24	+.006+.007	+.11	−.005−.002	−.06	+.002+.002	+.03	+.003	+.002	+.02	−.212	−1.72	−1.74
							+4.31÷(19.10×1.85)= +.122					−.42*÷20.56 =−.020			+.85†		−.56		+.23		−.14		+.07					+.03*	+.01
														+.85−.42=+.43*÷ 20.56=+.021		−.56+.43=−.13÷ 20.56=−.006		+.23−.13=+.10÷ 20.56=+.005		−.14+.10=−.04÷ 20.56=−.002		+.07−.04=+.03÷ 20.56=+.001							
II	5	0.5	6	120	+.3	4.70	+2.35	7.83	+.020	+.320	5.30	+2.65	8.28	−.061	−.51	+.008	+.07	−.007	−.06	+.002	+.02	−.002	−.02	−.060	−.032	−.50	+.288	+2.15	+2.17
	6	0.5	6	120	+.2	2.22	+1.11	5.55	+.020	+.220	2.65	+1.33	6.05	−.061	−.37	+.008	+.05	−.007	−.04	+.002	+.01	−.002	−.01	−.060	−.032	−.36	+.188	+0.97	+0.98
	2	0.5	6	120	−.4	8.00	−4.00	10.00	+.020+.122	−.258	3.56	−1.78	6.90	−.061−.020	−.56	+.008+.021	+.20	−.007−.006	−.09	+.002+.005	+.05	−.002−.002	−.03	−.062	−.034	−.43	−.292	−2.21	−2.21
	7	0.5	8	100	−.2	0.77	−.38	1.90	+.020−.107	−.287	1.49	−.75	2.61	−.061−.015	−.20	+.008+.009	+.04	−.007−.004	−.03	+.002+.004	+.02	−.002−.002	−.01	−.068	−.037	−.18	−.324	−0.93	−0.94
							−0.92÷(25.28×1.85)= −.020					+1.45*÷23.84 =+.061			−1.64†		+.36		−.22		+.10		−.07					−.02*	.00
														−1.64+1.45=− .19*÷23.84=−.008		−.19+.36=+.17÷ 23.84=+.007		−.22+.17=−.05÷ 23.84=−.002		+.10−.05=+.05÷ 23.84=+.002		−.07+.05=−.02÷ 23.84=−.001							
III	4	2.0	8	100	+.1	.21	+.42	4.20	−.008+.122	+.214	.87	+1.74	8.14	−.002−.020	−.18	+.008+.021	+.24	−.007−.006	−.11	+.002+.005	+.06	−.002−.002	−.03	−.003	−.002	−.02	+.212	+1.72	+1.74
	8	0.5	6	120	+.3	4.70	+2.35	7.83	−.008−.107	+.185	1.92	+.96	5.19	−.002−.015	−.09	+.008+.009	+.09	−.007−.004	−.06	+.002+.004	+.03	−.002−.002	−.02	−.009	−.005	−.05	+.180	+0.91	+0.92
	9	0.5	6	120	−.2	2.22	−1.11	5.55	−.008	−.208	2.40	−1.20	5.77	−.002	−.01	+.008	+.05	−.007	−.04	+.002	+.01	−.002	−.01	−.001	−.000	.00	−.208	−1.20	−1.20
	10	2.0	6	120	−.1	.61	−1.22	12.20	−.008	−.108	.72	−1.44	13.32	−.002	−.03	+.008	+.11	−.007	−.09	+.002	+.03	−.002	−.03	−.001	−.000	−.01	−.108	−1.45	−1.44
							+0.44÷(29.78×1.85)= +.008					+.06*÷32.42 =+.002			−.31†		+.49		−.30		+.13		−.09					−.02*	+.02
														−.31+.06=−.25*÷ 32.42=−.008		+.49−.25=+.24÷ 32.42=+.007		−.30+.24=−.06÷ 32.42=−.002		+.13−.06=+.07÷ 32.42=+.002		−.09+.07=−.02÷ 32.42=−.001							
IV	7	0.5	8	100	+.2	0.77	+.38	1.90	+.107−.020	+.287	1.49	+.75	2.61	+.015+.061	+.20	−.009−.008	−.04	+.004+.007	+.03	−.004−.002	−.02	+.002+.002	+.01	+.068	+.037	+.18	+.324	+0.93	+0.94
	11	0.5	8	100	+.4	2.76	+1.38	3.45	+.107	+.507	4.32	+2.16	4.26	+.015	+.06	−.009	−.04	+.004	+.02	−.004	−.02	+.002	+.01	+.008	+.004	+.03	+.511	+2.19	+2.19
	8	0.5	6	120	−.3	4.70	−2.35	7.83	+.107+.008	−.185	1.92	−.96	5.19	+.015+.002	+.09	−.009−.008	−.09	+.004+.007	+.06	−.004−.002	−.03	+.002+.002	+.02	+.009	+.005	+.05	−.180	−0.91	−0.92
	12	0.5	6	120	−.4	8.00	−4.00	10.00	+.107	−.293	4.50	−2.25	7.68	+.015	+.12	−.009	−.07	+.004	+.03	−.004	−.03	+.002	+.02	+.008	+.004	+.07	−.289	−2.18	−2.20
							−4.59÷(23.18×1.85)= −.107					−.30*÷19.74 =−.015			+.47†		−.24		+.14		−.10		+.06					+.03*	+.01
														−.30+.47=+.17*÷ 19.74=+.009		−.24+.17=−.07÷ 19.74=−.004		+.14−.07=+.07÷ 19.74=+.004		−.10+.07=−.03÷ 19.74=−.002		+.06−.03=+.03÷ 19.74=+.001							

* Unbalanced head loss. † Change in unbalanced head loss.

required but once. It is possible, of course, that the first assumptions would be as fortunate as were Fair's. In that case the authors' method would be very simple indeed. The example given appears to be more typical of assumptions likely to be made in actual practice.

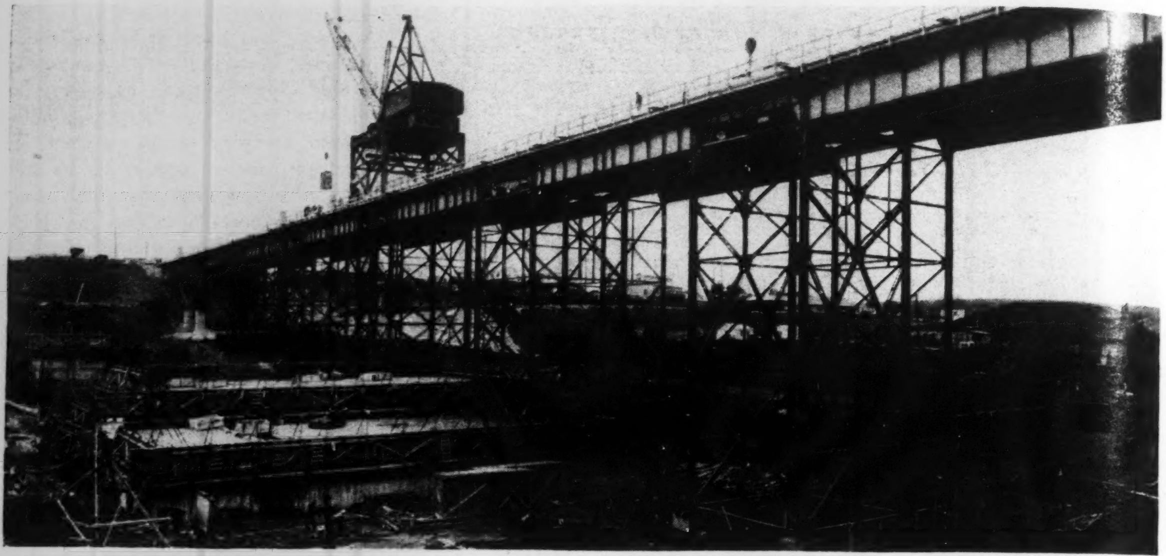
The authors have considered two other modifications of these methods which have some advantages. Both have been devised to avoid the necessity of the second use of the Hazen-Williams head loss tables represented by columns 11 to 14 of the table. The first requires that the value of $n\Delta Q$ for any circuit be arbitrarily scaled down until it amounts to no more than 20 percent of Q for any pipe in the circuit. Then a new value of Q and of h and finally of h/Q for each pipe is computed which can be used in subsequent balancing operations. This method does not reduce the number of column headings in the table and may even increase the number of trials for successful balancing. This is not recommended, however.

The other modification appears to have more merit. It utilizes the value of the second term in equation (2) as well as the first, for a more correct value of Δh. This term, $0.786\ (\Delta Q/Q)^2h$, is equal to $(\Delta Q/Q) \times 0.786/1.85$ [or approximately $n\Delta Q/(4Q)$] times $n\Delta Q$ times h/Q. Its sign is the same as that of h.

Now the change in h/Q which results from the change in Q is $1/n$ times the change in the derivative dh/dQ and the change in this derivative is approximated by the expression $n(n-1)\ h/Q \times (\Delta Q/Q)$. Hence the change in h/Q is approximately $(n/4)\ (\Delta Q/Q)$ times h/Q times 2. Its sign is the same as that of $n\Delta Q$.

Thus the value of Δh in any balancing operation is equal to $n\Delta Q$ times h/Q plus this value times $n\Delta Q/4Q$ and the new value of h/Q for use in the next balancing operation will be its original value plus the value of $n\Delta Q/4Q$, just computed, times twice the original h/Q. Furthermore, the second correction of h and any correction at all of h/Q may be dispensed with as soon as it appears that subsequent changes in Q are less than 10 percent.

Having tried all methods described herein, the authors favor the one illustrated in their example. They wish to acknowledge the helpful criticisms made by Prof. Fair in the preparation of this paper.



TVA's Cherokee Dam, where three revolving cranes on a trestle will place 771,000 yd. of concrete during 1941.

TVA Rushes Power for National Defense

***Contents in Brief**—In July, 1940, Congress authorized the Tennessee Valley Authority to increase its planned construction program by a 300,000-kw. increment of firm power to be ready in 20 months. This addition was requested by the National Defense Advisory Commission to care for increased manufacturing load in the valley, largely in connection with aluminum processing. The conditions, and construction program, which make this rapid increase economically possible are outlined here with a review of the power situation in the Tennessee Valley. Principal hydro project of the emergency program is Cherokee Dam, the construction procedure on which is described in detail.*

AN EMERGENCY construction program is under way by the Tennessee Valley Authority designed to increase its available firm power by 300,000 kw. in a period of 20 months to assist the defense program by providing more electric energy primarily for the aluminum industry, major units of which are located in the Tennessee Valley. This power will come from three major sources: a hydro development on an upper river tributary, a steam plant to "firm" the hydro power against high and low water flows; and installation of additional units at existing dams, justified by increased storage as upper river and tributary projects are completed. The cost of this added power is estimated at $65,800,000, of which $25,000,000 is available for the fiscal year of 1941.

When first formed, TVA was given control of Wilson Dam with its installed capacity of 184,000 kw. (firm power available was only 39,000 kw. during periods of low flow) and the Sheffield steam plant with 60,000 kw. capacity. Since TVA was created in 1933 it has completed six major dams and is actively engaged in the construction of four more. Generating capacity at the six dams completed is 447,800 kw. making a total of 691,800 kw. installed by government agencies.

During 1939, TVA acquired by purchase from the Tennessee Electric Power Co., five hydro plants with an output totaling 136,700 kw. and four steam plants having 135,000 kw. continuously available power. In addition a number of minor hydro, steam, and internal combustion engine plants were acquired totaling 14,250 kw., which have been retired to standby status or taken out of service.

Installed capacity of the privately owned plants in the Tennessee Valley prior to the advent of the TVA was about 306,000 kw. and that of the government owned plants (not used appreciably) 244,000 kw., a total of 546,000 kw. exclusive of the retired plants. To this the TVA already has added nearly 450,000 kw., bringing the present total to 984,800 kw. Additions to TVA plants authorized before the emergency program include installation of two new units at Wheeler Dam (one recently placed in service), two at Wilson Dam and one at Pickwick Landing to take advantage of the increased flow during the low water season from the storage reservoirs, three units at Watts Bar Dam, two at Fort Loudoun Dam (Coulter Shoals), and four at Kentucky Dam (Gilbertsville) a total of about 400,000 kw. installed capacity, which will become gradually available through 1945, with 242,000 kw. added to the system by the low water season of 1942. In addition to the normal construction outlined above the emergency program now authorized is expected to increase the firm power available in the TVA system 300,000 kw. by the end of 1942.

The emergency projects

At the time the National Defense Advisory Commission asked for the added power, studies of all hydro sites in the Tennessee Valley had been made, including computations of their effect on the rest of the system. Many locations had been investigated for foundation conditions so that information on all potential power development sites was ready and available for the start of construction operations.

Location of the principal structure of the emergency program, to be known as Cherokee Dam, is on the Holston River above Knoxville, where its storage can be utilized for power at all of the main river dams of the TVA system. The added water available thus justifies addition of two more generating units at Wilson Dam and one at Pickwick Landing Dam as well as three units at Cherokee, a total of 214,000 kw.

Watts Bar steam plant

To insure constant power when flood or low water reduce the efficiency of the hydro development, a steam plant is now under rush construction just downstream from the Watts Bar Dam. Construction of the dam was started in 1939, concrete for the lock and much of the spillway has been placed, with substantial completion expected late in 1941 and units in commercial operation by May, 1942.

The steam plant will have two 60,000-kw. turbines operating under a pressure of 850 lb. per sq.in. The burners are designed for economic use of the coal locally available with provision made for rail, barge or truck delivery. Fuel consumption of the two units under full load will be 56 tons per hr. Cooling water comes by gravity flow from the pool above the dam through 3,600 ft. of 78-in. concrete pipe.

Construction is being carried on by the same forces as the dam. A separate plant supplies the concrete required for the steam plant but most of the other facilities are shared by the dam and steam plant. Most of the concrete is placed by a guy derrick located so that the material can be handled by direct swing from the mixer. The mixer is set under a bin in the excavation located so that the top of the bin is about at ground level to permit dumping aggregate directly from trucks.

Cherokee Dam on the Holston River

Many factors contributed to the program for a rapid start and an early completion of Cherokee Dam. Preliminary investigations were complete, personnel was available, design could be patterned on previous structures and construction equipment, not available from other projects, could be quickly procured through an expedited purchasing system.

Surveys of the entire watershed had disclosed Cherokee as the most desirable site for rapid development of hydro power. Subsurface investigations were sufficiently comprehensive to disclose the true conditions so that no important changes in the plan have been necessary.

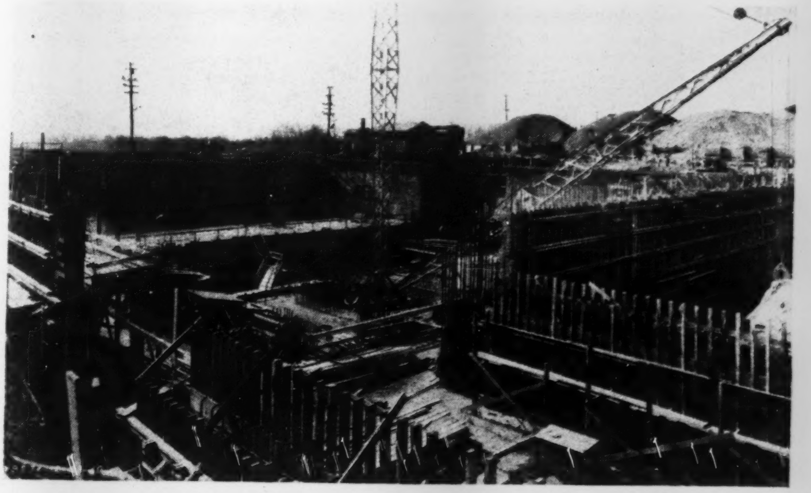
When personnel for the TVA was selected during the low point of the depression in 1933-34, advantage was taken of the fact that a large number of the best of the country's designers and construction men were available. Many have returned to private employment, but the others, now welded together into a smooth operating organization, are on hand to handle the rush program necessary. The required expansion of supervisory force has been generally accomplished by promotion of men with special ability.

In addition to the advantage of having a group of designers who have worked for several years on very similar problems for the nine previous TVA dams, the design of many parts of the Cherokee structure have been adapted from previously used plans. Sluice gates follow the Norris design and spillway radial gates have been taken "in toto" from Watts Bar and the order for them placed with the same firm to decrease design work and expedite delivery.

The permanent structure

The drainage area above the Cherokee site is 3,428 sq.mi. and the structure will have a storage volume of 1,640,000 acre-ft., of which 1,200,000 acre-ft. is controlled. The dam will consist of a concrete gravity spillway section 175 ft. high above rock foundation and 412 ft. long. This will be flanked by gravity non-overflow sections on either side, with a total length of 1,277 ft., which includes a 313-ft. powerhouse intake section. Impervious rolled-fill embankments, rock-faced, extend from either end of the concrete structure for a total length of 5,030 ft., thus making the total length of dam about 6,750 ft. In addition to this, two earth dikes, respectively 850 and 950 ft. long, close off saddles at the south end of the damsite.

About 771,000 yd. of concrete and 3,550,000 yd. of embankment fill will be required with more than 200,000 yd. of riprap and gravel for facing on the dam. The schedule calls for closing the diversion gates in January, 1942, so that the reservoir can be filled during the spring season.



At Watts Bar steam plant a guy derrick has been centrally located to handle most of the concrete and materials.

Unlike other dams recently started by TVA, very little suitable construction equipment was available for transfer to Cherokee Dam, thus giving the advantage of equipment selected specifically to fit the job but also requiring unusual activity to procure the necessary material in the defense rush. Final concrete plant planning was started a little in advance of actual authorization of the work, as considerable time was required for design, manufacture, and erection. Similarly, fast action was called for in specifying the grading equipment as stripping operation and the starting of the earthfill should be done in the dry fall weather and could not be continued actively through the winter.

Under the terms of the emergency authorization, equipment could be purchased without the restriction of competitive bids but this procedure has not been used. Instead two or more informal bids were asked, usually by telegraph, on each class of equipment, the bidder to quote on his standard product naming the proposed delivery date. Under this scheme 19 carloads of new equipment, largely for earthmoving and rock handling, were at the site two weeks after the rush defense program was authorized.

First operation for the earthfill section was excavation to impervious rock formations, which were cleaned almost as well as for concrete bond. Select material is then hand placed along the foundation contact and tamped with pneumatic rammers to insure a bond. The fill material is dumped by hauling units and spread by bulldozer on tractors which also draw tandem sheepsfoot rollers for compacting the major portion of the fill. Rock for the facing is secured from quarries opened near the site. Two new 4-yd. electric shovels are in use loading a fleet of twelve new 12-yd. heavy-duty trucks.

Hauling is done by several types of equipment; self-loading carrying scrapers drawn by two-wheeled or track-type tractors; 4-wheel tractors pulling bottom-dump trailers loaded by a power excavator or elevating grader; tractor-drawn track wagons largely used for hauling out muck and handling rock; and trucks used primarily on long haul rock. The carrying scrapers are used only on dirt, the 30-yd. wheel-tractor-drawn outfits being assisted by puller and pusher tractors to speed the filling.

Cofferdams were built the easy and economical way, in the dry. Temporary low earth dikes diverted the moderate summer flow and behind this a log crib cofferdam was constructed as illustrated. The stream is carried through a narrow channel between cofferdams, expected to handle up to a 3-year flood. The center bay of the cofferdam is sheathed with 1-in. boards and filled with earth dumped from trucks, then sluiced into place to make an impervious wall. Sections on either side are filled with rock for stability, and the stream side is faced with 1-in. boards to eliminate wash. Practically all of the crib material is timber salvaged from the reservoir clearing operation and used without sawing.

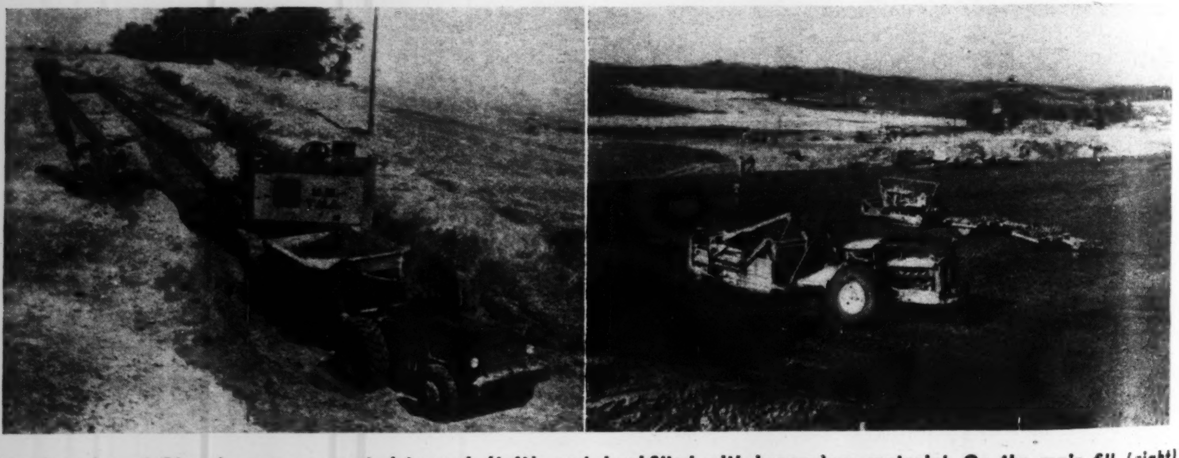
No serious problems of foundation are involved as good rock underlies the entire valley with only a few feet of overburden across the flood plain. Excavation is handled by power shovels loading tractor-drawn wagons.

Concreting plans

Several methods of placing concrete were studied, final selection being use of 40-ton revolving electric gantry cranes on a high trestle with concrete brought to the crane in bottom-dump buckets.

Concrete aggregates are crushed stone and manufactured sand purchased from nearby commercial plants and delivered by rail. Storage is provided over a 740-ft.-long laminated timber tunnel, set with the top at about ground elevation. Straddling the tunnel is a single-track railroad trestle, maximum height 86 ft., on which four sizes of rock and one of sand are dumped to store 150,000 yd. of material. This trestle is made up largely of rolled beams for both spans and towers. To eliminate obstructions to flow, the structure is designed with diagonal bracing only at bents between different materials and with a small amount of tower bracing which required special connection details to resist the impact expected from trains operating on the structure.

Reclamation from storage is through gates in the tunnel to a 36-in. conveyor which carries material over a rinsing screen to the mixing plant. Bulk cement is unloaded from cars by duplicate screw conveyors to bucket elevators set between the storage silo and concrete plant, with provision for deflection to either. Reclamation from the silo is by grav-



Core trenches at Cherokee are excavated to rock (left), and backfilled with impervious material. On the main fill (right) carrying scrapers haul and spread the earth, which is tamped by sheepsfoot rollers, followed by a disc.

ity through the bucket elevators. Each of the duplicate systems will handle 250 bbl. of cement per hour.

A 1,200-yd.-capacity hexagonal bin with six aggregate and one cement compartments equipped with automatic batching units will feed three 4-yd. front charging, tilting mixers through a turnhead under a collecting hopper. Capacity of the plant is planned for 240 yd. per hour with a 2-min. mixing time and a 3-min. cycle for each mixer. The mixers discharge a full batch into a 4-yd. bucket, two of which are set on a railroad flatcar which runs under the mixer plant.

Three new 40-ton-capacity (at 45-ft. radius) electric cranes with 125-ft. booms handle concrete and necessary supplementary material for the 173-ft.-high concrete structure. An 88-ft.-high trestle, largely heavy girder spans on tower bents will carry the cranes at about average ground elevation of the valley. The cranes are set on a 34-ft. gantry above the trestle and travel under their own power on 30-ft.-gage rails. Two standard-gage railway tracks for concrete trains are located between the gantry tracks while a third service track is located downstream from the gantry.

Adding a lift to the cofferdam at Cherokee in anticipation of the flood season.

Forms and concrete placing

The concrete will be placed in 5-ft. lifts with provisions for local cooling where severe conditions may occur. Cement will be a moderate-heat standard portland similar to that previously used by TVA. Four sizes of aggregates will be blended using cobbles up to 6 in. for the mass concrete.

Forms for the mass concrete have been developed from those previously used by TVA, a ruggedly built panel about 5½ ft. high by 50 ft. long designed to be lifted by an A-frame and ratchet chain hoist and held at the top by a tension-compression strut and at the bottom by anchors placed with the previous lift.

Concrete will be placed from single-line, manually-opened, bottom-dump buckets filled under the mixers, thus minimizing handling and segregation.

Construction schedule 20 months

Work on the construction plant, cofferdams and stripping the site was started in August, 1940. Earth embankment started immediately following the stripping and will require until early winter of 1941-42 for completion, with expected shutdowns through January to March of 1941. Concreting started on the spillway section in January, nearly a month ahead of the tight 20-month schedule. Some blocks are being left low for stream diversion while the center section of the dam is brought up. Work in the non-overflow and powerhouse sections will be carried on simultaneously with a completion date of April, 1942, for all except interior concrete.

The initial installation of three 41,500-hp. vertical shaft Francis turbines and 30,000-kw. generators will be completed in time for utilization of the stored water during the low water period of the late summer of 1942, when the power may be required for defense industries.

Personnel

T. B. Parker is chief engineer of TVA, A. L. Pauls chief construction engineer, and R. T. Colburn construction plant engineer. At Cherokee Dam Lee G. Warren is project manager; G. K. Leonard, construction engineer; and G. E. Murphey, superintendent.

PRESENT AND PROPOSED WATER CONTROL PROJECTS OF THE TENNESSEE VALLEY AUTHORITY

		Dam							Reservoir		
						Power					
Project	River	Max. height, ft.	Max. lock lift, ft.	Volume concrete, cu. yds.	Volume earth dam cu. yds.	Authorized installation, kw.	Ultimate capacity, kw.	Date of completion	Volume below top of gates, acre-ft.	Controlled storage acre-ft.	Total project cost
Kentucky ....UC	Tennessee.....	160	73	1,217,000	3,198,000	128,000	160,000	8/ /45	6,100,000	4,570,000	$105,000,000
Pickwick Landing........C	Tennessee.....	113	63	633,000	2,851,000	108,000	216,000	12/31/38	1,091,000	418,000	35,761,000
Wilson........CI	Tennessee.....	137	90T	1,240,500	0	234,400	444,000	4/ 1/26	535,000	....	36,192,000
Wheeler........C	Tennessee.....	72	53	748,200	0	129,600	259,200	7/31/37	1,150,000	429,000	35,770,000
Guntersville........C	Tennessee.....	94	45	298,987	836,516	72,900	97,200	7/ 1/40	1,019,000	282,000	31,605,000
Hales Bar........A	Tennessee.....	83	37	X	X	50,483	50,483	11/ 2/13	125,000	....	7,000,000
Chickamauga........UC	Tennessee.....	129	56	500,639	2,510,615	81,000	108,000	1/ /41	705,000	377,000	34,792,000
Watts Bar........UC	Tennessee.....	97	70	446,200	436,500	90,000	150,000	12/ /41	1,132,000	370,000	35,000,000
Fort Loudoun........UC	Tennessee.....	135	80	X	X	64,000	96,000	6/ /44	365,000	105,000	29,000,000
Norris........C	Clinch........	265	..	1,015,524	71,608	100,800	100,800	7/31/37	2,567,000	2,020,000	30,937,000
Hiwassee........UC	Hiwassee.......	307.5	..	793,000	0	57,600	115,200	2/ /41	438,000	365,000	17,385,000
Ocoee No. 1........A	Ocoee........	135	..	160,000	0	18,000	18,000	....	76,600	25,800	X
Ocoee No. 2........A	Ocoee........	30	..	R	0	18,800	28,200	....	0	0	X
Blue Ridge........A	Toccoa........	167	..	0	1,500,000	20,000	20,000	....	197,500	183,000	X
Great Falls........A	Caney Fork....	92	..	X	X	29,370	29,370	....	54,500	49,400	X
Cherokee........UC	Holston........	175	..	771,000	3,550,000	90,000	120,000	1/ /43	1,640,000	1,200,000	34,500,000

C — Constructed by TVA
CI — Constructed prior to TVA
UC — Under construction by TVA — Data subject to revision

R — Rock-filled crib

A — Acquired by purchase from Utilities
T — Twin locks
X — No definite figures available

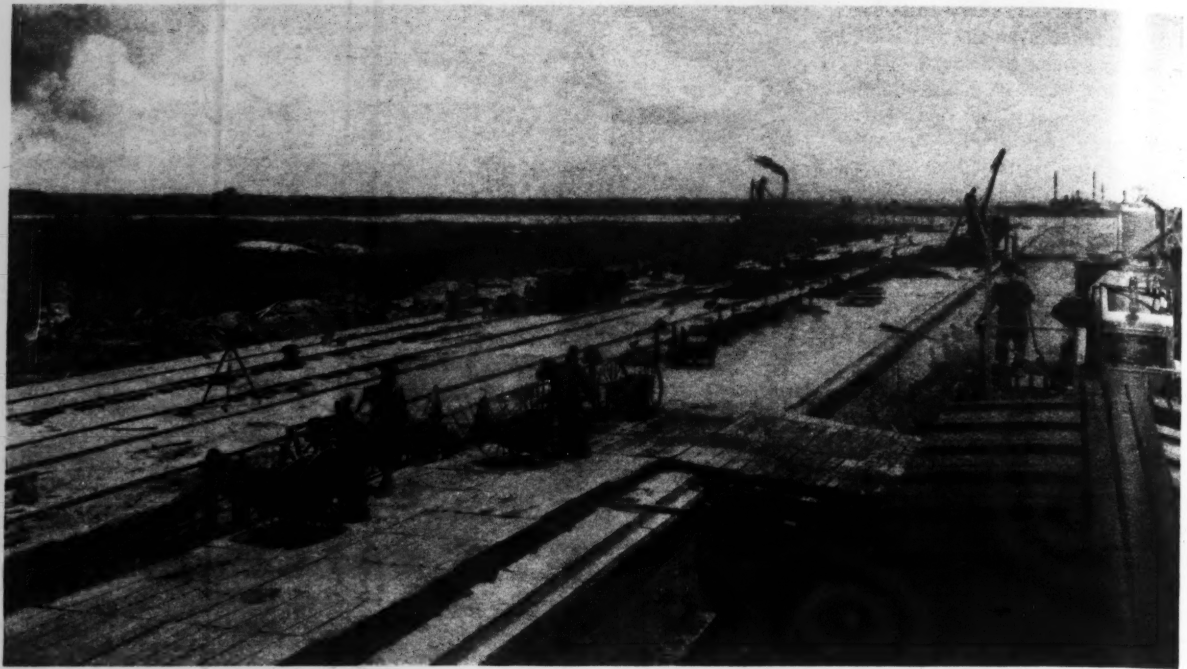


Fig. 1. The concrete wharf with its three tracks was built before the slip was dredged.

Port Structures Provide for Settlement

H. E. Myers

Engineer, J. B. Converse & Co., Mobile, Ala.

Contents in Brief*—Economy in original cost and reduced maintenance expenses were made possible by the development of improved designs for the new wharf and transit shed recently added to the state-owned port facilities at Mobile, Ala. The transit shed is designed to permit settlement of the underlying material without injury to the structure and the arrangement of the wharf has been modified from that of earlier wharves to obtain more efficient use of available space.*

CONTINUED GROWTH of the Alabama State Docks in Mobile, Ala., has necessitated the construction of additional ship berths and transit sheds, which were recently completed under a PWA loan and grant of $760,000. This new addition consisted of an apron wharf 1,225 ft. long, a transit shed 133 x 1,000 ft., and tracks, roads and other appurtenances. The new structure is notable in that considerable economy was obtained by developing a design that permits settlement of the fill under the long transit shed without injury to the wharf or the shed itself.

In general arrangement, this addition follows that of the original plan for the docks, an apron wharf with three marginal tracks and crossovers, a transit shed with rear loading platform, a depressed house track, and paved highway.

The wharves are of reinforced concrete supported on concrete piles varying in length from 45 to 60 ft. Each of the three tracks and their crossovers are laid in slots in the concrete and held in place by anchor bolts embedded in the concrete. The shed is a steel frame with galvanized corrugated roof and siding, reinforced concrete footings, pilasters and curtain walls, and supported on wood piles. The wharf was constructed on dry land and the slip at its

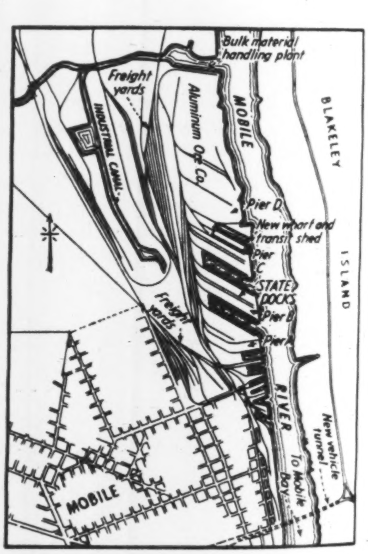


Fig. 2. The State Docks at Mobile lie north of the city where space is available for slips to accommodate large vessels and where direct rail connections could be made easily. The first unit of these states-owned facilities was built 16 years ago.

front was dredged after completion of the wharf.

After ten years of operation of the original system, it had become apparent that some improvements could be made by slightly changing a few dimensions and details. These changes were incorporated in the new structures with the anticipation of lower initial, operating and maintenance costs. Following are some of the more notable departures from the original plan.

The new apron wharf has a width of 56 ft. instead of 70 ft. and the number of batter piles was increased to offset the decrease in width. Two of the marginal wharf tracks were continued by a curve to serve the outshore end of the wharf lying parallel to the river instead of stopping at the angle in the wharf as they do on the older structures. The new transit shed has a width of 120 ft. instead of 60 ft. and its roof was designed for a single peak instead of two, thereby eliminating the valley gutter, which has been particularly objectionable. The floor and paving system in the shed and open areas was designed for a predetermined settlement, the approximate extent of which was known from past experience.

The site of this project was originally marshland, which has been filled by means of hydraulic dredges. The material overlying the compact sand stratum, which is approximately 35 ft. below ground surface, is about 5 ft. of sand fill and then 30 ft. of soft silt. The bearing value of this material is very low and all wharves and buildings must be supported on pile foundations. But as the cost of supporting the large shed floor areas on piles would be excessive, they are laid directly on a sand fill with the full realization that they will settle, adequate provision being made in the structure to permit settlement of floors without damage to the rigidly supported frames of doors, waterlines, downspouts, and wall slabs.

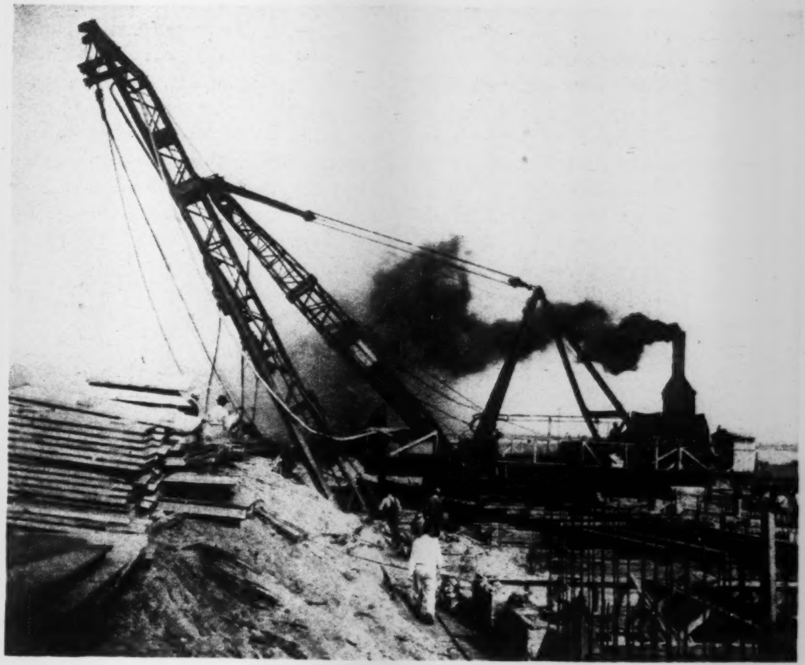


Fig. 3. Driving batter piles for the new wharf. The transit shed now stands on the high ground at the left. The batter piles are 16x16 in., 50 ft. long.

The rolling steel doors, located on the wharf side of the building, presented no problem due to settlement because their frames would be supported on the wharf itself. They were installed in the usual manner. The steel guides for all doors from the top of the concrete pilaster to the floor line were recessed in the pilaster to eliminate damage to them by trucks.

Doors on the rear and end of the shed are rigidly supported from

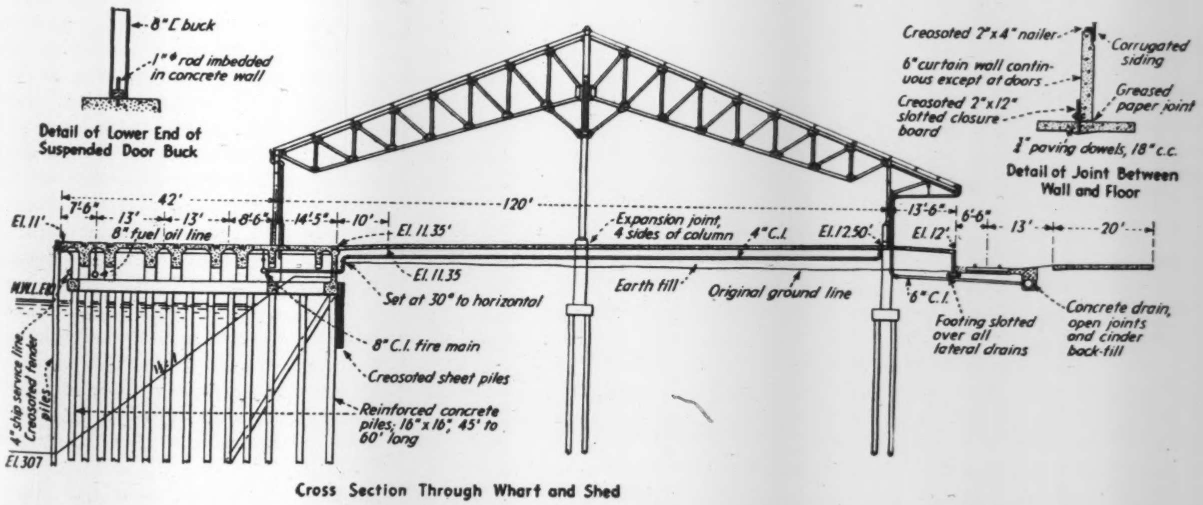

8" [buck
1" ϕ rod imbedded in concrete wall
Detail of Lower End of Suspended Door Buck
Creosoted 2"x4" nailer
Corrugated siding
6" curtain wall continuous except at doors
Greased paper joint
Creosoted 2"x12" slotted closure board
¾" paving dowels, 18" c.c.
Detail of Joint Between Wall and Floor
42'
120'
7'-6"
13'
13'
8'-6"
14'-5"
10'
13'-6"
6'-6"
13'
20'
El. 11'
8" fuel oil line
El. 11.35'
Expansion joint, 4 sides of column
4" C.I.
El. 12.50'
El. 12'
M.H.W.L. El.
El. 11.35
Set at 30° to horizontal
Earth fill
Original ground line
6" C.I.
Footing slotted over all lateral drains
Concrete drain, open joints and cinder back-fill
8" C.I. fire main
Creosoted sheet piles
4" ship service line
Creosoted fender piles
Reinforced concrete piles, 16"x16", 45' to 60' long
El. 30.7
Cross Section Through Wharf and Shed

Fig. 4. The superstructure of the transit shed is carried on the wharf and on deep pile-supported footings that are independent of the shed floor. This arrangement permits settlement of the floor without distortion of the building frame.

above, whereas the shed floor is not rigidly supported and will settle. The clear door opening height was specified as 12 ft. but, after settlement of the floor, the opening would be approximately 12 ft. 8 in. To insure the doors making a tight closure at the bottom after settlement, the doors were specified to have extra length of slats and guides.

The majority of these doors were framed directly to the main building columns, but several were too narrow to permit this method of support. The latter, with their bucks and guides, were suspended from the eave truss, which connects column tops. The bottom of the channel buck was provided with an angle clip, the outstanding leg of which was punched for a 1-in. rod. When the concrete floor was poured, the 1-in. rod was inserted vertically in this hole and its end embedded in the concrete with 12 in. projecting above floor level. This arrangement holds the bottom of the door in position even after the floor has settled.

The main sprinkler and fire main is rigidly supported by hangers from the under side of the wharf slab. All laterals for standpipes in the shed pass through the rear wall of the wharf into the sand fill under the shed floor slab. These pipes are rigidly supported at the wall and provided with two 90-deg. bends and a short piece of pipe, which act as a toggle joint and allow settlement without breaking the pipe.

The downspouts at the rear of the transit shed are connected to the building, while the underground drainage pipe is laid on cypress running boards in sand. The connection between the steel downspout and cast-iron lateral to the drain is provided with a slip joint, which will permit 8 in. of settlement without pulling the two apart. All pipe bends were strapped to the lines.

The problem of eliminating the opening caused by the settlement of floors under the rear curtain wall was solved by attaching a 2 x 12-in. creosoted board with slotted holes to the concrete curtain wall. This board is bolted to the wall and may be lowered as the floor settles.

To eliminate abrupt breaks in grade where the shed slabs connect to the rigidly supported wharf the connection was made on a concrete lip cast on the wharf. This condition of slabs supported on only one edge has previously caused the slabs to crack badly. To correct this condition, all slabs were provided with an abruptly rising grade and an expansion joint not more than 10 ft. distant from the supported edge. In this manner, when the slab settles, the grade is flattened and the cracking or breaking is controlled by the expansion joint.

All surface drainage was designed for the conditions which will exist after settlement.

As this structure is situated in a region subject to hurricane winds and tides the shed is designed to resist winds of high velocity and the top of the wharf was set well above the highest hurricane tide level, El. 9.5. The top of the wharf is at El. 11 and cast-iron vents were set in the wharf slab to decrease hydrostatic pressure under the slab should a storm tide go above the level of the wharf.

Design and supervision of the work was handled by J. B. Converse & Co., engineers, Mobile, which firm has handled engineering and construction work for the Alabama State Docks Commission for the past few years. The various contracts were executed by the following firms: apron wharf, Raymond Concrete Pile Co.; transit shed, Rust Engineering Co.; tracks and paving, Hancock Co.; sprinklers, Crawford-Slaton Co.; dredging, Murnan Dredging Co.; transit shed, Pate Construction Co.

How to Operate a Sludge Digester

Sewage Sludge Digestion is a major problem at many sewage treatment plants, and a review of the difficulties which may occur and methods of preventing or remedying them are given by D. C. Reybold, of The Dorr Co., in *The Clarifier*, official bulletin of the South Dakota State Board of Health. A major cause of trouble lies in the method of starting the digester, as a poorly started tank may create difficulties for several years. Three essential requirements for good operation are temperature, alkalinity and seeding control. If these are handled properly, little foaming or other trouble occurs.

Foaming causes and cures have not been completely determined, but enough is known for its prevention in most cases. As a rule it may be traced to lack of control of either temperature, pH or seeding. The best temperature is 90 to 95 deg. F., the optimum pH is 7 to 7.5, and seeding should be controlled by frequent and small removals of digested sludge.

Lack of heat in the digester is a serious omission during the starting period. A tank becomes filled with cold undigested sludge and when digestion does begin it will be acid and accompanied by large volumes of offensive and unburnable gas. Generally foaming then occurs. It is a long and expensive process to convert the tank contents to an alkaline condition, as it is difficult to stop the growth of acid-forming bacteria. In one case, this change required 13 months. In another case, after three months of poor operation the tank finally was drained and heat and lime were applied as it was being refilled, and no acid troubles occurred.

As to pumping, Mr. Reybold said that operators in both small and large plants have a tendency to pump sludge too rapidly and for too long a period. Pumping for two or three minutes every hour not only keeps a small clarifier clean, but also feeds the digestion tank more uniformly and thus aids in the production of a clearer supernatant liquor and more uniform gas flow.

The following rules are suggested as a guide to good operation: (1) Pump sludge to digester at low rates and pump frequently for short periods; (2) sample the pump discharge and cease pumping when sludge becomes thin; (3) keep temperature of digester between 90 and 95 deg.; (4) do not withdraw sludge in large quantities, and always leave sufficient digested sludge in the tank to serve as seeding; (5) start digestion tank by heating it and adding lime so as to prevent acid conditions; (6) keep scum broken up to permit easy passage of gas; and (7) make daily analyses on pH and temperature, and on volatile matter when possible—these will provide a good index on the condition of tank.

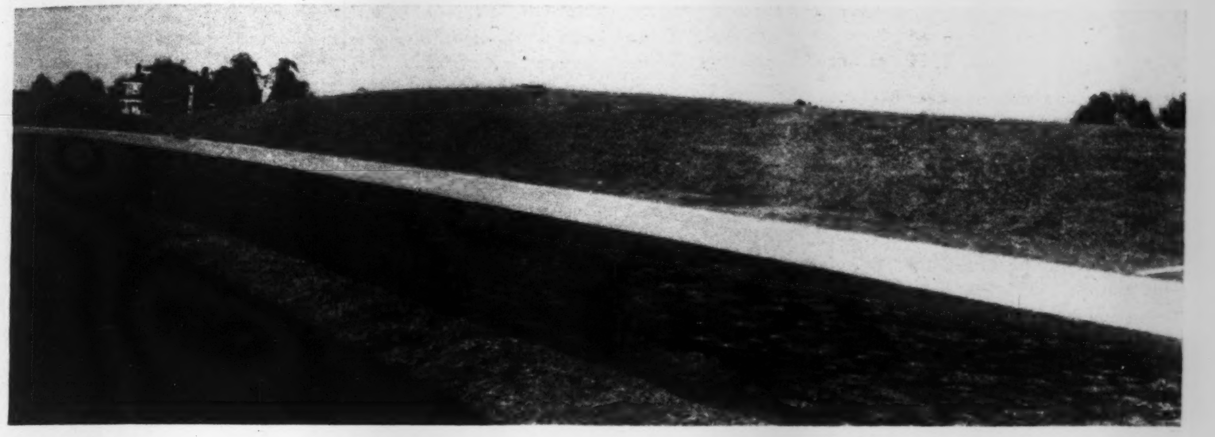


Fig. 1. Blue grass sod is a handsome slope cover but it requires fertile soil.

Erosion Control Reduces Road Upkeep

C. C. Tevis

Assistant Division Engineer, State Highway Department, Kirkwood, Mo.

Contents in Brief*—Erosion control is a good investment and the methods are simple when made a part of the original construction. Good practice includes channelization, slope retards and planting with vegetation selected according to the character of the soil. Actual upkeep cost items due to erosion show that a substantial expenditure for control is profitable.*

Maintenance Expense shows a heavy debit charge due to erosion on typical Missouri roads. It appears that something over $50 a mile annually in cost of upkeep could have been saved had reasonably good erosion control been built into these roads. Altogether it is indicated that investment in erosion control pays in reduced maintenance. A breakdown and an analysis of the costs are given later but first the causes of erosion where it occurs and methods of controlling it call for understanding.

The causes of erosion are drought, frost and rain; water and frost are the more widespread causes but in many regions drought and wind are important eroding agencies. Erosion occurs chiefly on roadside borders including shoulders, ditches, backslopes and fill slopes but it is also a factor on certain surfaces. Consideration here is limited to erosion from water on roadside borders.

Erosion control in cuts

In cuts the first work is to channelize drainage and the second is to provide backslope cover. The recommended form of channelizing is an intercepting gutter along the back slope just back of the crest heading to down-slope flumes discharging into a toe ditch. But in erosive soil an open ditch at the crest of the backslope is worse than no ditch as water will seep from the ditch down slope as shown by Fig. 2 and cause slides. Paved gutter and flumes are necessary; the best is cobblestone but cheaper forms are an asphalt-stone mix and blue grass sod. The price range per square yard is about: cobble stone, $3; asphalt mix, $1.30, and sod, 30c.

CONSTRUCTION PROVISIONS THAT REDUCE EROSION

1. Stockpile topsoil so that infertile fill slopes and backslopes can be blanketed with it.
2. Construct subdrains on the uphill side of the cut to intercept all seepage planes in rock cuts.
3. Construct ditch retards so that the velocity of the ditch water will be reduced to a non-erosive speed.
4. Construct some form of headwall or grouted revetment on all sideroad or farm-entrance pipe to eliminate erosion around the pipe.
5. Use some form of asphalt mix or concrete from edge of pavement for a distance of at least 10 ft. at all entrances so that loose material will not be forced on the pavement.
6. Construct drop inlets of higher than adjacent ground located in a deep abrupt area, so ground around inlet will be forced to fill up and thereby eliminate field erosion.
7. Build spillways and retards on steep grades at culvert outlets.
8. Compact with a sheepfoot roller all fills and the bottom 2 ft. of cuts.
9. Slope shoulders into pavement and provide lip curb or gutter for shoulder water.
10. Remove and replace all unstable material.
11. Construct slopes proper to the material encountered rather than a standard 2:1 or other slope.
12. Blend backslopes and fill slopes into original ground by variable roundings.
13. Build surfaced turnouts on earth shoulders for tire repair, etc.
14. Construct watertight pipe gutters from end of cut to an elevation that will not erode.
15. Flatten backslopes to 1 on 4, where height is not too great and yardage unreasonable, to eliminate snow deposits, as experience has been that snow does not lodge readily if the slopes are flat.

Slope cover must follow drainage but it should not be undertaken until all water entering the highway from adjacent land is collected and removed by channelization. In planning cover for backslopes it has to be remembered that the earth is somewhat in its natural undisturbed position while on fill slopes it is placed ground. A second consideration not to be forgotten is that the slope soil (generally subsoil) has to be analyzed and the missing ingredients for plant growth added. Then the plant cover to be used, whether grass, vines or bush growth, is that which suits the soil and, on occasion, provides quick growth. Where practicable, grassing is generally preferable for quick growth and close coverage and it may be grown by seeding or close sodding; sodding will cost about 20c. per sq. yd. and seeding about $100 an acre.

Fill and shoulder protection

Three effective methods of reducing erosion on fill slopes are brush edgings, strip sodding and staked wattles. They cost respectively about $250, $400 and $400 per slope acre. All should be parts of the original construction operation and in proper season each should be supplemented by seeding protected by a straw cover. The brush edging is cheapest and more efficient. As shown by Fig. 3a an edging strip of willow brush, twisted straw, buck brush or other similar material is embedded just in from the slope face on contour lines. The edging can be placed by ditching in from the slope face but it is cheaper if the contractor brings up this fill in level lifts to place it during construction. These brush edgings will prevent erosion for a time and if a mixed seed (a quick growing seed and another seed that has a longer root but is slower growing) is planted on the slope after it has been fertilized a stable well-shaped fill practically free from excessive maintenance costs will result. The two other methods of slope protection are shown by Figs. 3b and 3c.

Practically all shoulder failures except rutting are caused by erosion or settlement of the slopes; therefore the first and most important recommendation for shoulder protection is to provide positive control of the fill slopes. Some form of asphalt-stone mixture placed in the shoulder for a width of 2 ft. and a depth of 6 in. adjacent to the pavement is worthwhile on heavily traveled roads, but it is hard to justify the cost on light-traveled roads. The greater the volume of traffic the greater will be the rutting of the earth shoulder adjacent to the pavement and the greater the maintenance cost will be, unless some form of surfacing is provided that will not rut. Seeding, with a proper amount of fertilizer and straw, should be placed on all shoulders that are sufficiently fertile to produce growth.

Erosion increases upkeep

State highway departments commonly seem to plan on the theory that all sections of a highway should be built to one standard, then if any parts fail to function properly that condition will be remedied by maintenance. One often sees the same cut on fill slope used throughout whether the earth is a rich black loam or a stiff yellow clay. It is easily possible to build against erosion and some of the ways are enumerated for quick reference in an accompanying summary. The reward is cheaper upkeep. Actual costs recorded on four Missouri roads show money being spent for maintenance that would be materially reduced by erosion control. The records averaged for two years, 1937 and 1938, are given in the accompanying table; only the items affected by erosion are included.

Fig. 4. A mulch of straw is a vital provision for seed growth but does not replace a fertile soil.

It will be observed that four very different sections of road have been chosen, namely, a 30-ft. gravel section, a 40-ft. portland cement concrete section, a 24-ft. gravel section and a 21-ft. portland cement concrete section to establish these facts—yet all produce the same answer. The major costs of maintaining concrete pavement, exclusive of regular surface maintenance, are: first, reshaping shoulders, cleaning ditches, etc.; second, filling minor washes on slopes; and third, cleaning dirt off the pavement. Both the 24-ft. gravel and the 30-ft. gravel sections have similar costs, except that no attempt is made to clean dirt off a gravel road.

All will concede that proper ero-

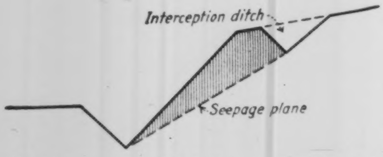


Fig. 2. A crest ditch for a cut slope in erosive soil is likely to cause slides; it should be paved and lead to paved down-slope flumes that empty into a toe ditch.

MAINTENANCE COSTS PER MILE DUE TO EROSION

	Gravel Rt. 100	40′ Pavt. Rt. 61	24′ Grav. Rt. Z	21′ Pavt. Rt. 40TR
Cleaning pavement	$ 3.77	873.76	0.00	120.90
Filling minor washes, etc.	343.69	613.92	0.00	649.29
Blading, dragging, rolling shld.	34.70	90.71	0.00	166.50
Reshaping shld., cleaning ditches	492.67	1917.18	636.44	661.14
Mulching, seeding, etc., to restore sod	28.36	193.40	0.00	111.79
Repairing slides in fills	66.56	0.00	0.00	0.00
Removing slides in cuts	27.84	85.80	0.00	0.00
Repairing ditch chks., etc.	55.50	163.15	27.85	2.73
Cleaning, repairing subdrains	0.00	83.20	0.00	0.00

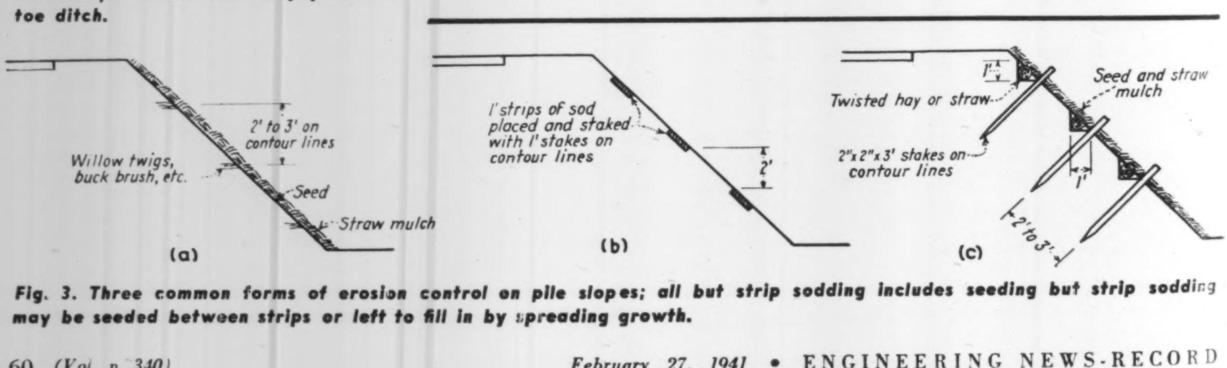

2' to 3' on contour lines
Willow twigs, buck brush, etc.
Seed
Straw mulch
(a)
1' strips of sod placed and staked with 1' stakes on contour lines
2'
(b)
1'
Seed and straw mulch
Twisted hay or straw
2"x2"x3' stakes on contour lines
1'
2' to 3'
(c)

Fig. 3. Three common forms of erosion control on pile slopes; all but strip sodding includes seeding but strip sodding may be seeded between strips or left to fill in by spreading growth.

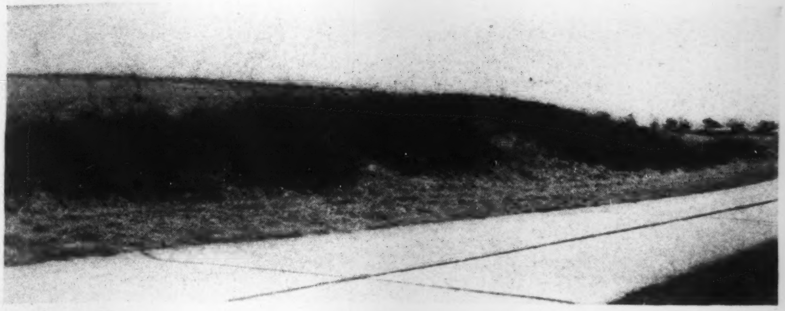


Fig. 5. Rose bushes will often flourish on soil that is too poor to maintain grass growth. Proper fertilization and mulching are essential to accelerate growth.

sion control will eliminate 80 percent of the dirt from the pavement, reduce the work of filling minor washes 90 percent, and reduce the work of reshaping shoulders, etc., at least 75 percent. Using these figures, it follows that $678.82 could have been saved on Route 100, $2,689.42, on Route 61, $572.80, on Route Z, and $1,176.93 on Route 40TR, had adequate and proper erosion control been provided in the program of original construction.

It appears from these data that $5,197.97 could have been saved in maintaining these four sections of road which have a total mileage of 43.7 miles, during the years of 1937 and 1938. This represents a saving per mile of $116.50 or a saving for this division, which is composed of twelve counties or a total of 1,760 miles, of about $20,500. Applying this same reasoning to the entire state of Missouri, which is composed of ten divisions, would mean a saving of well over a million dollars in maintenance costs for the state highways during a two-year period.

The conclusion is therefore evident that maintenance costs can be reduced materially by properly providing for erosion control during construction, and the highway will be made more pleasing to the eye and safer for travel.

A Folding Dipper Dredge

John D. Rauch

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Contents in Brief*—*A 3/4-yd. dipper dredge that will pass under a 10-ft. vertical clearance bridge and through 14-ft.-wide locks is now doing cleaning work in an old canal at Akron, Ohio. The superstructure drops quickly to 9 ft. above the waterline and detachable pontoons provide width and stability.

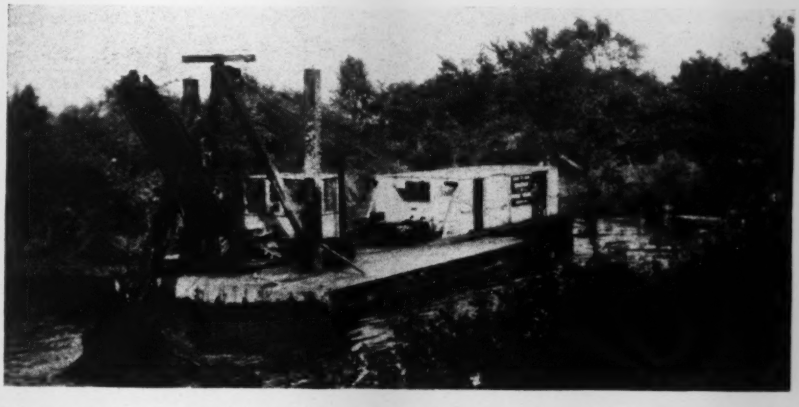
MANY NEW ENGINEERING FEATURES are incorporated in a dipper dredge recently put in operation near Akron, Ohio, by the department of public works of Ohio. It is actually a folding machine as the superstructure can be folded down to low vertical clearance and pontoons, which normally provide side stability, trail the outfit.

The dredge is operated on the Ohio Canal, a part of the old Ohio & Erie Canal, which extended from Cleveland on Lake Erie to Portsmouth on the Ohio River. The canal is no longer used for transportation purposes but is now the main source of water supply for several large tire manufacturing plants and other industries located along its course. The consumption of water is increasing and, as the state receives remuneration for the water service, it is desirable to maintain the channel at its maximum capacity, hence the dredging.

Due to restrictions along the canal the use of a machine working from the bank is impracticable, and a dipper dredge seemed the logical solution. There are 16 bridges under which the dredge must pass that have a maximum clearance height from water to bridge beams of 10 ft. and a span between abutments sufficient to allow only a 26-ft. width of hull; also there are a number of locks that must be negotiated which are slightly more than 14 ft. wide by 80 ft. long. The dredge had to be capable of digging to a depth of 10 ft. and of dumping at a height of 15 ft. and a radius of 35 ft.

To meet these conditions it was necessary to design the vertical spuds, boom and A-frame so that they may be lowered, by power, to a height permitting the passage under the bridges, and that the hull be designed with removable pontoons on the sides for passing through the locks.

The hull proper is constructed entirely of steel in a sectional design, with two solid longitudinal bulkheads. The forward 10-ft. section is an integral welded unit equipped with the vertical spud wells which are of a unique design to permit the spuds,



Dipper dredge designed to fold down to 9 ft. above water, can be moved under low bridges. Draft is 1.8 ft. while the dredge is operating.

When the dredge is moving under bridges an auxiliary barge supports the dipper. Passage requires 4 hr. including lowering and raising of superstructure.

when raised clear of the bottom of the hull, to be lowered backward as indicated in the illustration. These spuds are steel, 28 ft. long and 12 in. square. They are provided with racks meshing with pinions which are operated by means of a cable and drum, and are equipped with a gravity lock. The rear of the hull is provided with a frame for the trailing spud which is of telescopic design and also operated by cable.

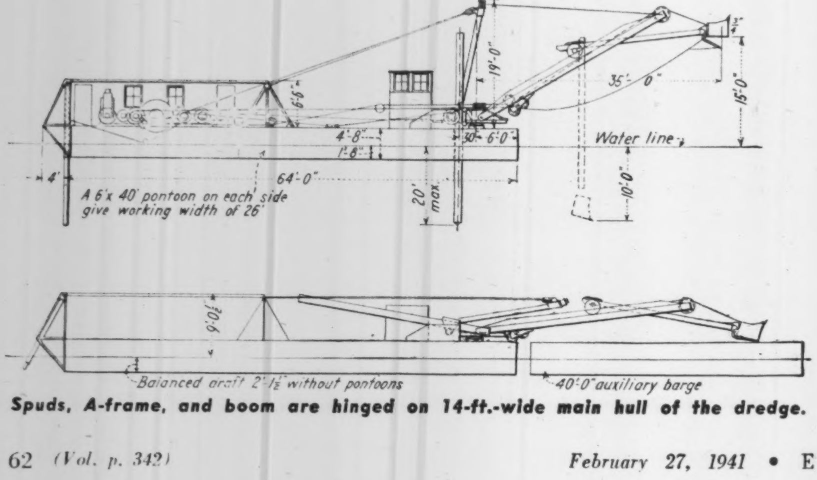
The pontoons are each 6 ft. wide by 40 ft. long by 4 ft. 4 in. deep. of all-welded construction of ¼-in. plates, secured to the sides of the hull by bolts at the top and removable links at the bottom. They are provided with sea cocks for sinking them to the proper depth for convenience in connecting and disconnecting them.

Boom and dipper design

The boom is of steel construction about 32 ft. long, with cast steel dipper shaft and pinions and provided with cast steel sheaves for the hoisting and backing cables, as well as an extra point sheave to permit the use of a clamshell bucket if desired. It is hinge-pinned to a turntable center which is operated by cables from the swinging drums.

The ¾-yd. dipper is manganese steel, adjustably attached to the welded dipper handle and is operated by a single line of 1-in. cable, the machinery being compound-geared to give a speed of 84 fpm. and a pull of 16,000 lb., thus eliminating the necessity of the customary padlock sheave on the dipper. The A-frame has an overall height of 21 ft., is of all-steel welded design, and is hinged to the top of the truss connecting the two vertical spud casings. It is raised and lowered, through five parts of cable, by a reversible worm-driven drum.

The main machinery is powered by a diesel engine operated at a governed speed of 850 rpm. and connected by an inclosed silent chain drive and power takeoff clutch. The exhaust is fitted with a silencer for use in highly populated areas. The operating machinery provides one main hoisting drum, 26-in. dia., controlled through a compounded outside band clutch and brake, one backing drum and one extra clamshell drum, both 20-in. dia., equipped with double screw-operated cone clutches. There are 3 spud-cable drums and 2 swinging drums, all 13-in. dia., operated by similar type of clutches, and a worm-driven boom hoist drum equipped with reversing clutches. All control levers are conveniently banked for ease of operation. A 1,500-watt automatic electric plant equipped with a gasoline engine is provided for lighting.



Spuds, A-frame, and boom are hinged on 14-ft.-wide main hull of the dredge.

The total weight of the dredge is approximately 89 tons and the draft 1.8 ft. when in operation. In actual performance the dredge is capable of being passed under bridges in 4 hr. including the lowering and raising of the superstructure, and passed through locks in one day including the removal and later re-attaching of the pontoons.

Acknowledgments

The dredge was built by the American Steel Dredge Co., Inc., of Fort Wayne, Ind., to specifications drawn by Frank L. Rashig, director of public works of Ohio and his chief engineer, F. O. Kugel. The entire dredge, including the hull, was fabricated complete in the factory at Fort Wayne and transported 230 miles to the job in convenient sections by trailer truck, then bolted together in the field. The erection was in charge of M. A. Adams, who has had many years' experience in the erection and operation of dredges in various parts of the world. B. J. Clevenger is resident engineer in charge of the dredging operation.

Slum Clearance by Demolition

Substandard houses in the blighted areas of Detroit have been demolished to the number of 6,000 in 1940. In Toronto, Canada, in the last four years, K. S. Gillies, commissioner of buildings recently reported 8,000 substandard buildings have been repaired and 1,200 demolished following 11,000 inspections.

Navy Housing in Norfolk

***Contents in Brief**—To accommodate married enlisted men and their families stationed at the Norfolk Navy Yard, two large housing projects are under way. One of these, being built by the Bureau of Yards and Docks, typifies the design and construction features of Navy Department low-cost housing projects. The other project under construction by the Norfolk Housing Authority is an example of USHA defense housing.*

AT NORFOLK, VA., one of the biggest and oldest bases of the U. S. Navy, housing for married enlisted men attached to the fleet or to base operating units is one of the problems created by expanding defense activities. With characteristic efficiency, however, the Bureau of Yards and Docks, public works arm of the Navy, has swung into action on a major housing project totaling 1,042 family units. And the Norfolk Housing Authority is cooperating in the program to provide other Navy families with adequate low-cost living quarters by building a 500-unit project.

In addition, the Bureau also has under way a 1,200-unit project at nearby Newport News, where civilian shipyard workers will be housed. The two Navy Department projects are part of the 45-million-dollar program that the department has begun, and are typical of the standardized design that is being utilized. The cost per family unit is estimated at $2,200, including the installation of sewers, water, electric and gas utilities, as well as street paving. Rental rates have not yet been determined, but it is anticipated that an apartment consisting of living room, bedroom, dinette, kitchen and bath will rent for $15 a month. About half the apartment units contain two bedrooms, and for these the rent will be slightly higher.

Design and construction

Typical of the standardized design and construction plan worked out by the Bureau of Yards and Docks is the 1,042 family project adjacent to the Naval Operating Base. Here a flat plot of ground covering about 48 acres was selected for the site. Rectangular in shape with dimensions of about 700x2,900 ft., the site was laid out as shown in Fig. 1. The three longitudinal streets are 40 ft. wide, thus providing space for parking cars (no garages are included in the project) on both sides, and yet permitting two-way movement of traffic. Alleyways 10 ft. wide parallel to the street and in the rear of houses give access for service needs. All utilities are carried in the alleyways, thus eliminating underground pipes or overhead poles on the street.

A total of 92 buildings will be erected to accommodate the 1,042 families. There will be 57 twelve-family units (two stories high), 24 fourteen-family units (two stories high except for one-story unit at each end), and 11 one-story units.

Concrete and steel

Design and construction features of all the units are standardized, the principal details of which are shown in Fig. 2.

It will be noted that no basements are provided. The first floor is a reinforced concrete slab carried on foundation walls which are about 2½ ft. high, to elevate the first floor above all recorded storm-tide levels in this area. The second floor is a 2-in. concrete slab poured on corrugated, galvanized iron forms.

Exterior walls are constructed of $2\frac{5}{16}$x2-in. (1.7-lb.) steel studs, placed 24 in. on centers. These studs are formed with two back-to-back channel shapes. To support the second floor, 8-in. steel joists are used. The double-pitched roof, which is covered with sheet metal, is supported by light trusses formed with 2½-in. channels. This is the patented Stran Steel type of construction.

Interior partitions, except for bearing walls, are framed with 2x2-in. pine studs, 24 in. on centers.

Exterior wall coverings

The exterior wall coverings are of two types. About one-third of the houses will be covered with asbestos-cement siding. The balance will have a covering of simulated brick fiberboard extending from the ground level to the bottom of the second-story window, and above this a ½-in. Gunite finish on light gage wire mesh.

The simulated brick material is asphalt-impregnated fiberboard backing covered with a mastic into which crushed brick granules are pressed. Each sheet is 3 ft. 6 in. in length, and the width shows 4 to 5 brick courses.

The interior finish will be of ⅜-in. composition wallboard applied in sizes large enough in most cases to cover

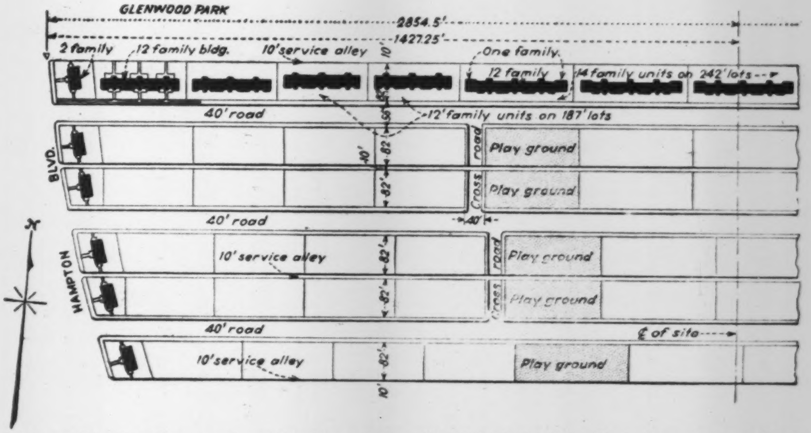


Fig. 1. Straightline community layout for the 1,042 family Navy housing project at Norfolk. The 92 buildings consist mainly of 12 and 14-family houses.

the entire side of a room. Wall sections are fastened with metal clips. The first floor ceiling, also of ⅜-in. wallboard, is fastened with clips nailed to the bottom of joists, while the second floor ceiling, of the same material, is secured to wood packing placed in ceiling channels.

No plaster or paint will be applied to the walls. The concrete floors will be covered with asphalt tile.

Each apartment will be equipped with a refrigerator, range, hot water heater and heating unit. The latter will be of the forced air type, probably gas-fired. In connection with these utilities it should be noted (Fig. 2) that the bathroom and kitchen are separated by an 8-in. wall, which provides space for compact and economical arrangement of the plumbing facilities.

The total cost of the project, which is being built by the Byrne Organization of Dallas, Tex., is about $2,284,000.

Norfolk Housing Authority

Differing in design, construction materials and cost from the Bureau of Yards & Docks housing, is the 500-unit Merrimack Park project of the Norfolk Housing Authority. The purpose of the project—to provide living quarters for married enlisted men of the Navy and their families—is the same, however.

Originally conceived as a USHA slum clearance project, the Merrimack Park project was finally launched as a defense housing job. The entire amount of the cost, $1,641,000, is being loaned to the Norfolk Housing Authority by the USHA from funds previously earmarked for the city on its slum clearance plan application.

The financing plan

The financing plan, according to George H. Lewis, director of the local housing authority, is on a 60-year basis. The rentals, plus a subsidy from USHA, will carry all charges on the project. These charges include, in addition to amortization and maintenance costs, a service fee of $8,700 per year which the authority will pay to the city. The city will not levy taxes against the property, but does make a service charge for certain essential services which have been provided, such as sewers, water, etc. The amount paid as a service charge is considerably less than the tax would be, however.

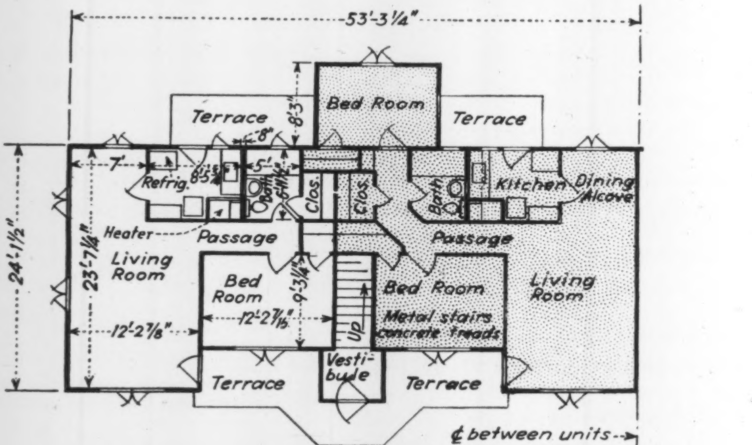
The rentals have been establishe at $17.50 average per family unit this does not include utility service which will probably be about $6-7 pe month per family. The cost per uni including all utility and other facilities, will be about $3,900.

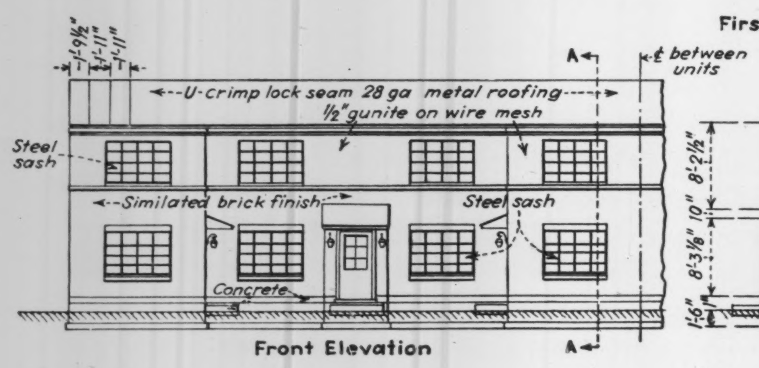
Varied assortment of buildings

The 198 dwelling buildings at Merrimack Park (there will be also a community building and others to be used for general purposes) are arranged in a half-circle layout on a site near the Ocean View section of Norfolk.

Three different types of buildings will be built in varied assortment, so as to break up the uniformity of the project. These include two-famil single-story units of frame construction, four-family single-story units of cinder block construction, and six-family two-story units of brick construction. In the latter the bedrooms for each family will be on the second floor.

The contractor on this project is Ralph S. Herzog of Philadelphia, who is working on a 150-day building schedule. Work started Oct. 21, and the completion is set for March 15, 1941.


53'-3¼"
Terrace
Bed Room
Terrace
8'-3"
8"
7'
5'
Refrig.
Clos.
Clos.
Bath
Bath
Kitchen
Dining Alcove
24'-1½"
23'-7¼"
Heater
Passage
Passage
Living Room
Bed Room
9'-3¼"
Bed Room
Living Room
12'-2⅞"
12'-2⅞"
Metal stairs concrete treads
Up
Vestibule
Terrace
Terrace
¢ between units
First Floor Plan


1'-9½"
1'-11"
1'-11"
A
¢ between units
U-crimp lock seam 28 ga metal roofing
½" gunite on wire mesh
Steel sash
Similated brick finish
Steel sash
Concrete
Front Elevation
A

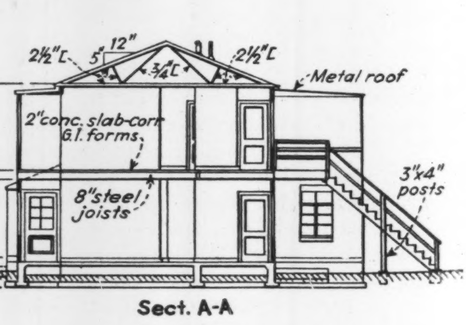

2½"[
12"
5"
¾"[
2½"[
Metal roof
8'-2½"
2" conc. slab-corr G.I. forms
10"
8" steel joists
8'-3⅜"
1'-6"
3"x4" posts
Sect. A-A

Fig. 2. Details of the multiple-family two-story Navy houses in which the frame is of steel construction and all floors are poured concrete. An extension provides the extra bedroom in the 4-room apartment. Cost has been held to $2,200 per unit, including utilities and roads. The simulated brick-finish exterior is an asphalt-impregnated fiberboard back with a mastic into which crushed brick granules have been pressed. Interior finish consists of wallboard applied in large sections and fastened with metal clips. The first floor is a reinforced concrete slab supported on foundation walls.

Pavement Marking in Ohio

***Contents in Brief**—Ohio has adopted a yellow barrier line paralleling a center-of-road line at prohibited passing points. The machine used to produce 1 to 3 lines at a cost of $4.77 per mile of road exclusive of paint operates at speeds up to 8 mph.*

OHIO HAS DEVELOPED a truck for painting center lines and parallel barrier lines on 9,000 miles per year of the state's highways. The truck operates at speeds up to 8 mph. and it is expected that 35 to 40 miles per day can be painted after experimental work gives way to routine operation. The state has adopted the system of traffic line marking for two-lane roads recommended by the American Association of State Highway Officials, using a continuous white or black line on contrasting color pavement to mark the center. No-passing zones have been instituted wherever the clear sight distance is less than 600 ft., and these are marked by a yellow stripe parallel to and on the side of the center line from which crossing is prohibited. Surveys conducted by the division of traffic and safety of the Ohio highway department indicate that the yellow stripe is more effective than parallel white lines or other designs.

Ohio was one of the first states to develop a mechanical device for applying paint lines to mark the center on pavements. The device first used, a push-type outfit, seems quite primitive now yet it did the job of applying the lines far better than hand application. Brushes were mounted between two sliding guide plates which kept the line uniform in width. A much improved adaptation of this machine, built in the highway department shops, is still being used throughout the state.

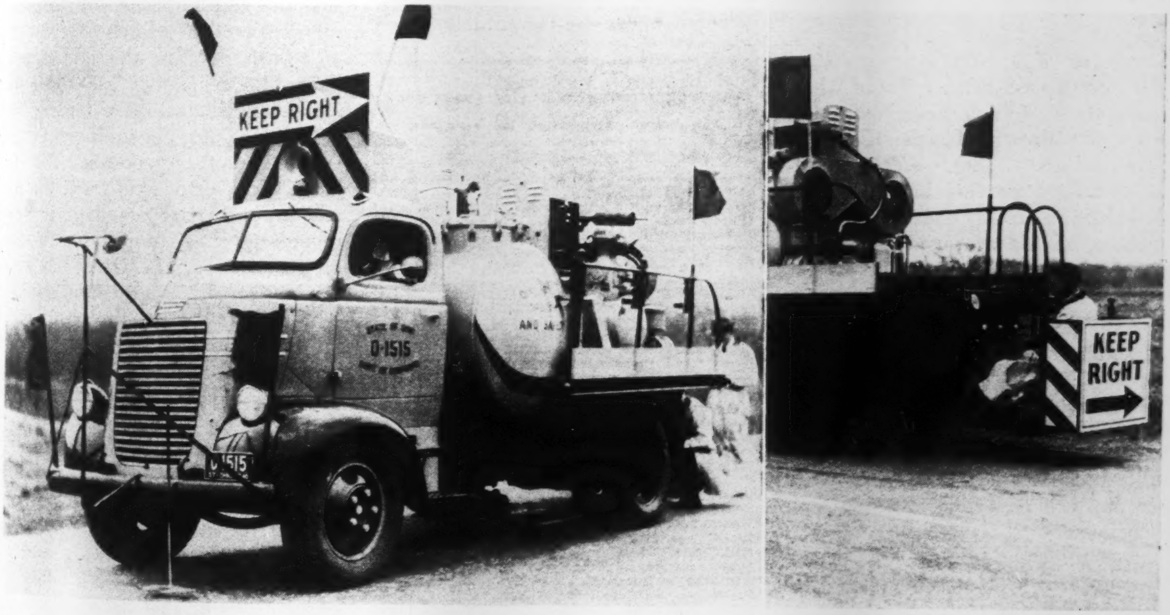
As the highway mileage that must be center-lined has grown faster methods have had to be employed. A self-propelled, spray-type unit was developed, which was faster than the brush-type unit and reduced the amount of paint required but the operator still walked behind the machine.

Cost data and observation of the field operations showed that not even this type equipment was the answer to the problem of marking about half of the 18,000 miles of road of the state system each year. As long as the operator walked behind the machine, the production was limited to how far the man would walk in a day. Actually, the production of any operator was cut down by delays due to stopping to fill the small paint container, waiting for the line to dry, etc. A riding-type unit was the next step but the first of these units were small and had little paint capacity, so that stops for refilling were frequent for efficient operation.

During the summer of 1939 studies were made of the equipment in other states which, combined with Ohio's experience, guided the development of the present truck-type center line machine. All equipment and parts are assembled standard units except the paint tank, which was specially built.

New paint unit

The machine paints three lines and two colors simultaneously or in any combination. All lines are 4 in. wide and have a 3-in. space between the yellow lines and the white center. The paint storage tank carries 500 gallons of paint in its two compartments, a supply sufficient for a complete day's



Special line painting truck used in Ohio. Operator's seat on rear as shown at right. By using the mirror and sight shown in the left view the driver is able to produce a smooth, properly aligned curve.

operation of either color. Paint is loaded into the paint reservoirs by a pump on the unit and kept thoroughly mixed by air-motor-driven paint agitators built into the storage tanks.

Compressed air for operating the unit is supplied by a 60-cu.ft. compressor. The paint is applied by air-controlled atomizing type spray guns with the lines kept to their prescribed width by air curtains instead of by the usual metal shields. Air for these curtains is supplied by a blower.

Two men on the truck do all the work necessary to make the line. The driver keeps straight lines on tangents by sighting over a guide, not shown in the picture; and by using the mirror and the sight shown he maintains the proper alignment on curves. The operator on the rear of the truck controls start and continuation of all lines. He also places the guards on the wet paint to protect the lines from traffic while drying. The unit is designed to operate at speeds up to 8 mph. with the first summer's operations averaging 20 miles per 8-hr. day.

It should be pointed out that this unit is only an experimental one and operation this year has been on an experimental basis. Instead of assigning the unit to one division, it has been operated for a short time in each of the twelve highway divisions and has proven successful under many different conditions; on narrow roads, heavy traffic roads, in hills of southeastern Ohio and the plains of northwestern Ohio.

From May until the middle of November this truck-type marking machine painted 1,800 miles of white center lines and lane lines, and 1,265 miles of yellow no-passing lines. All were continuous lines. Costs of application have been very low even with the shifting from one division to another, having averaged only $4.77 per mile of highway and $3.47 per mile of line, including labor, truck operating costs, mixing and loading paint, and all time lost because of bad weather. The white paint has been applied at an average rate of 11.5 gal. per mile of 4-in. continuous line and the yellow paint 9.3 gal. per mile. It is expected that the mileage per day can be nearly doubled with a corresponding reduction in cost.

The information for this article was supplied by Harry E. Neal, chief engineer of the Division of Traffic and Safety of the Department of Highways in Ohio.

Highway Maintenance Equipment

Contents in Brief—Virginia's highway maintenance and construction equipment is held in a central pool from which it can be "rented" on an hourly basis for whatever work requires it. Field maintenance service by full-time mechanics operating from local points and bulk plants for fuels assist in keeping rates for fueled and maintained equipment well below usual rental levels.

The Department of Highways of Virginia has developed a central control bureau to handle the equipment necessary for maintenance and the minor construction done by its own forces. This bureau purchases the new equipment, maintains and fuels it, and "rents" it at nominal rates to whatever project requests the machines. Rentals are on an hourly basis except for cars, which go out on a monthly arrangement. Equipment thus held has a replacement value of about $5,000,000. Some equipment is purchased new each year, its average life is 9 years so the average age is 4 to 5 years. Equipment owned by the state is only the amount of any class which can be kept in use most of the time. For peak requirements additional equipment is rented from private owners for the project which has temporary need for machines.

Interdepartmental rental rates for highway equipment in Virginia

Rate per hour of use except as noted.

Automobiles	(per mo.)	$70.00
Survey trucks	(per mo.)	60.00
Trucks (old) on which compressors are mounted		.15
1½-ton trucks		.40
3 and 3½-ton trucks		.50
5-ton trucks		1.00
Small bituminous distributors		.65
Big bituminous distributors		1.20
Truck-mounted concrete mixers		1.20
60-80-hp. crawler tractors		1.40
Tandem-drive motor graders		1.10
10-ton gas rollers		1.20
10-ton steam rollers*		.50
¼ and ⅜-yd. gas shovels		1.20
½ and ⅝-yd. gas shovels		1.60
¾, 1 and 1¼-yd. gas and diesel shovels		3.00
Steam cranes*		1.30
40 to 80-hp. gas and diesel power plants		.75
60 to 165-ft. engine-driven compressors		.60
260 to 360-ft. engine-driven compressors		1.30
7x12 to 9x16 crushers, elevators, screens & bins		.85
Power cultivator		.25
Gravel washing plants		.60
Pneumatic drills (hose & steel not included)		.15
Wagon drills (hose & steel not included)		.60
12 and 14-ft. graders (scarifier teeth not included)		.30
Mill type chip spreaders		.45
Power sweepers		.25
2 to 3-bag concrete mixers		.50
Pavers		.80
Rotary snow plows		15.00
15-ton trailers		1.50
Mud jack		1.00

* Fuel and water not included.

A large repair shop is maintained near Richmond where a permanent force makes all major repairs. To centralize operations, the office work and record-keeping for all equipment is done at the same location. From this point all transfers of equipment are initiated and purchases made. Heavy machinery requiring overhaul is brought in by trailers even from distant parts of the state.

At each of eight district headquarters modern repair equipment and adequate space are provided for all but the major repairs. An equipment superintendent and 15 to 20 men keep all machines in the area in first-class order. Equipment is stored at the district headquarters during periods of non-use as it has been found desirable to bring even the heaviest pieces to the central location in the district for protection and ease of dispatch to a new location.

Fuel supplied

Rental rates charged include fuel necessary for operation except on steam equipment where isolated use makes it better to keep the hourly rate low and let the user provide coal and water.

The highway department has 16 bulk plants taking rail delivery of gasoline and kerosene with provision for diesel oil at points where equipment use justifies the added tanks. From these plants 1,000-gal. tank trucks distribute to 416 underground tanks with pumping equipment at conveniently located points. The tank truck takes a full load from the plant and must dispose of all of it before reloading, thus simplifying a check on distribution. The driver has a master key to all underground tanks so that he can fill them, through a meter, in the absence of the patrolman responsible for the particular pump. This has saved considerable time as deliveries by oil company trucks required that a man be on hand to check and sign for the fuel received. A check is now provided by accurate measurement of the content of such underground tank morning and evening and by comparison of this with requisitions of fuel drawn for equipment and the disbursement report of the tank truck driver. Losses of gasoline are confined almost entirely to machines left unguarded on the road overnight.

Rental rates low

The appended tabular data gives the rental rates now charged the project on which the equipment is used. Work is generally on a 48-hr.-week basis but equipment is charged on an hourly use basis except for cars, which are charged for by the month. Time is not charged during inclement weather or when breakdowns of the particular equipment or essential supplementary machines force a shutdown of the work and they cannot be used, as there is no work to which they can be temporarily shifted. Neither is time charged for machines, even though on a job, if work is not available for them; but the equipment pool reserves full control over this to prevent idle equipment on one project and lack of it on another. Cost of delivering machinery to a particular job is charged to the project partly in the forms of rentals for trucks and trailers. Movement from the job is charged to the next work the machine goes on.

A substantial factor in the rental rates is the pay of the personnel. Junior mechanics receive $85 to $100 per month, senior mechanics $100 to $125 and the foremen $125 to $145. All employees are on an annual basis rather than the seasonal employment of many highway workers. In the summer, general maintenance provides work; in the winter, equipment is overhauled and the men are available as experienced operators for relief snow removal duty.

No depreciation charges are set up for individual equipment but rental charges are established at a level to provide funds for the purchase of a normal amount of replacement equipment.

In some years rental charges have given an abnormal return. During 1939 a long construction season built up a substantial surplus and unusual snows added to maintenance equipment hours. Consequently the fund had built up "on paper" to a point where the equipment bureau was able to cancel charges on 68,000 hours of rental on all classes of machines when money for snow removal costs were not available from established funds.

Some special equipment necessarily has an hourly rate out of proportion to its value due to the few hours it will be used per year. An example is a blower type snow plow at $15 per hr. compared to a 1¼-yd. shovel at $3 per hr. The snow plow even then is rated at less than its cost as the tendency of the various districts is to use patrols and truck plows rather than the high rated machine.

Cost of operations

To arrive at the proper charges for each class of equipment and to watch individual pieces for abnormal costs, simple but complete records are kept. The figure shows: (*a*) card filled out daily to designate charges and show fuels used; (*b*) top, parts, materials and tires used for a specific machine, and below, the reverse side of the card showing individual labor charges and materials and tires total for a month; (*c*) a one-month portion of the annual history of the vehicle. Gain or loss is determined by the algebraic sum of revenue less operating costs, maintenance, depreciation, and overhead.

Replacement of worn equipment is made on examination of this card in the light of the possible effect of the failure of the specific machine to function and the cost in loss of rentals and employee efficiency. No definite means of evaluating these items has been worked out.

A word of caution

In making comparison, other users of equipment should note the following factors which enter into the low rates shown:

(1) No return is sought on the investment.

(2) No taxes are paid on the value involved.

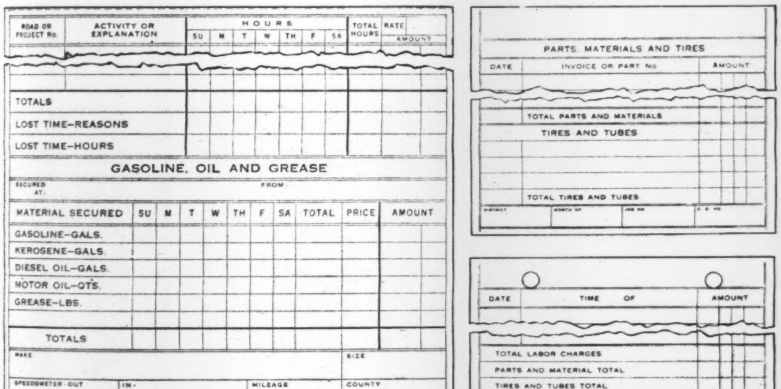
(3) No fuel tax is paid.

(4) Figures are kept merely for accounting purposes, no money changes hands.

(5) Equipment units are frequently used as pace setters on heavy construction, but the majority are on normal maintenance work of the department.

Information on equipment ownership and operation was obtained from R. P. Ellison, equipment engineer of the Department of Highways of the State of Virginia.

H. G. Shirley is commissioner of the department. C. S. Mullen is chief engineer. T. F. Loughborough is construction engineer and J. J. Forrer maintenance engineer.



ROAD OR PROJECT NO.	ACTIVITY OR EXPLANATION	HOURS SU	M	T	W	TH	F	SA	TOTAL HOURS	RATE AMOUNT
TOTALS										
LOST TIME—REASONS										
LOST TIME—HOURS										

GASOLINE, OIL AND GREASE

SECURED AT: FROM:

MATERIAL SECURED	SU	M	T	W	TH	F	SA	TOTAL	PRICE	AMOUNT
GASOLINE—GALS.										
KEROSENE—GALS.										
DIESEL OIL—GALS.										
MOTOR OIL—QTS.										
GREASE—LBS.										
TOTALS										

MAKE

SIZE

SPEEDOMETER OUT

IN

MILEAGE

COUNTY

EQUIPMENT NO.

CONDITION (✓)

GOOD ☐ FAIR ☐ POOR ☐

WEEK ENDING

OPERATOR

PARTS, MATERIALS AND TIRES

DATE	INVOICE OR PART No	AMOUNT
	TOTAL PARTS AND MATERIALS	
	TIRES AND TUBES	
	TOTAL TIRES AND TUBES	

DISTRICT

MONTH OF

JOB NO.

E. O. NO.

DATE	TIME OF	AMOUNT
	TOTAL LABOR CHARGES	
	PARTS AND MATERIAL TOTAL	
	TIRES AND TUBES TOTAL	
GRAND TOTAL		

MAKE

DISTRICT

MONTH OF

JOB NO.

E. O. NO.

LEGEND
G—GOOD CONDITION
F—FAIR CONDITION
P—POOR CONDITION

MAKE

CAPACITY

EQUIP. NO.

YEAR

ANNUAL HISTORY CARD

COND.	ACTIVITY HRS. USED	HRS. IDLE	REVENUE	PERIOD	OPERATING COSTS GAL.	GAS-OIL GREASE	MAINTENANCE	DEPRECIATION	OVERHEAD	GAIN OR LOSS
				JULY						1
										2
										3
										4
										5
										M
										TOT

Simple but complete records are kept of operations and expense on each piece of equipment rented by the department.

From Field and Office

Working problems and time-saving methods for engineers and contractors

A New Pycnometer Test Eliminates Soil Drying

A new pycnometer test eliminates the usual time-consuming drying operations in testing soil mixtures for stabilized earth roads. The new device shown by the accompanying sketch has an overflow spout that accurately controls the water level and keeps the jar from being wetted by overflow; it also permits all but the 1-in. material to be introduced into the jar with the metal cap in place. Besides the pycnometer the only apparatus required for a field test is a set of sieves (1-in., ½-in., No. 4, No. 10, No. 40 and No. 100); a 5,000-gram single-beam trip scales; a few pans and a 3-gal. pail. In the field tests with this apparatus the procedure is as follows:

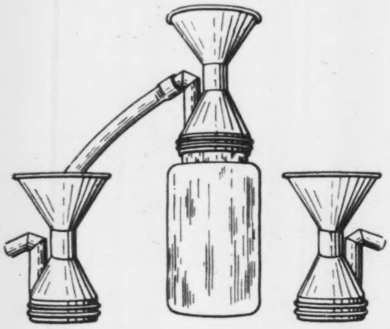
1. The pycnometer is calibrated by filling it with water up to the point of overflow and recording this weight (*A*). To assure uniformity in the volume of the apparatus, the cap should be screwed to the same position each time. This can be accomplished by filing a small notch on the pycnometer cap and a corresponding one on the fruit jar.

2. Pour out about two-thirds of this water and after removing the cap place in the pycnometer 2,000 grams of undried and unbound stabilized material. Shake the jar gently to remove any entrapped air in the immersed sample. Then replace the cap to the same position as above and fill with water to the point of overflow and record this weight of water and material (*B*).

3. Remove the cap and the contents of the jar and wash the sample over the specified sieves.

4. Fill the jar about three-fourths full of water and place the material retained on the 1-in. sieve in it. Then screw on cap and fill with water to point of overflow and record this weight (*C*).

5. Place the material retained on each of the successive sieves in the jar through the funneled cap and record the accumulated weight of each after the dripping at the overflow spout has stopped.



New type pycnometer cap simplifies gradation tests.

6. Calculate the percent retained on each sieve as follows:

Percent retained on sieve = $\frac{C-A}{B-A} \times 100$.

This method of obtaining the gradation of stabilized materials has sufficient accuracy to warrant its use in all field tests such as, (a) mixture control at stabilizing or proportioning plants, (b) checking windrowed material for proper addition of binder-soil for surface consolidation, (c) checking local sand and gravel deposits, (d) checking gradation of binder-soil, such as on the No. 40 and No. 100-mesh sieves, and (e) demonstrating rapidly the amount and type of material needed in a road surface to meet the usual gradation limits for stabilized mats.

This information is condensed from an article in "Calcium Chloride Association News" by Fred Burggraf, research engineer, Highway Research Board, National Research Council.

Turning Tin Cans Into Dollars

Tin cans coming to the incinerator of the Washington Suburban Sanitary District at Hyattsville, Md., command a nice price today and justify salvage. The district, which accumulates 2½ to 3 tons of cans daily, sells them to a chemical works for $9 a long ton (2,200 lb.) delivered.

The district requires separation of cans from refuse, and formerly put the cans on a dump. A baling machine was purchased recently to compress the cans into small bundles weighing about 35 lb. each. This machine cost slightly under $3,000. One man operates the machine and bales from 160 to 175 bundles per working day.

Carl Hechmer, engineer of the Washington Suburban Sanitary Commission, showing bales of tin cans salvaged from refuse.

Western States Mark Safe Speed for Curves

Some of the midwestern and mountain states are adding reflectorized numerals to curve warning signs to indicate the safe speed at which the curve may be traveled. The accompanying illustration shows the type of warning signs being installed by Illinois (left) and Wyoming to the (right). Authorities in both states report a reduction in accidents from over-running curves since the signs were installed.

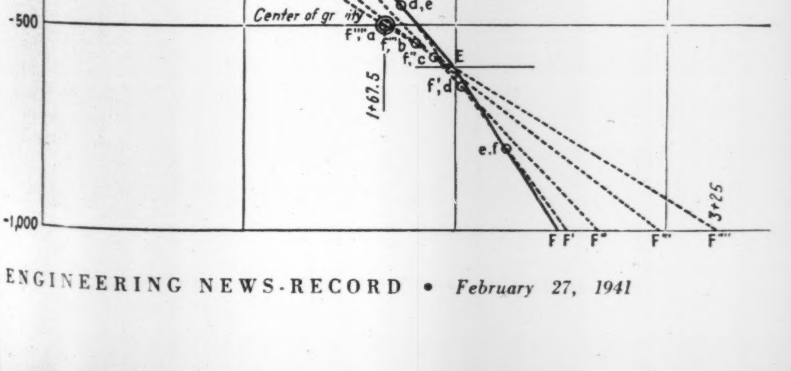
Graphical Method of Making Overhaul Computations

A very useful and time-saving method of locating the center of gravity of any irregular section of a mass diagram is shown by the accompanying diagram.

Given: A, B, C, D, E, F, any section of a mass diagram; and it is required to find its center of gravity.

First, locate the center of each straight line in the section as: ab, bc, cd, de, and ef. Next, through points ef, and de, draw the construction line $D'F'$. On this line $D'F'$ locate its center, $f'd'$, and through this point and cd, draw a second construction line $C'F''$ and locate its center $f''c'$. Through $f''c'$ and bc, the construction line $B'F'''$ is drawn. This procedure is continued until the final construction line, $A'F''''$ is located. The center of gravity, $f''''a'$, of the section A, B, C, D, E, F is located at the midpoint of the construction line $A'F''''$.

This method may be applied to sections composed of any number of straight lines.—John B. Skewes, Jr., *Transitman, Utah State Road Commission, Salt Lake City, Utah.*



Stations to Miles Conversion Formula for Highway Projects

In reconnoitering a highway project prior to making a bid the contractor will find the following method useful in changing distances as taken from the plans in stations to equivalents in miles so that a speedometer may be used for measuring from any point of beginning to any other desired point. The method, which is based on the use of 0.00019 as a reciprocal of 5.280, is illustrated by the following example:

Station: 32 28.24 = P.O.B. of Project
Station: 145 90.50 = Intersection of Side Road *R*, to unloading point.

32 nearest full station
146 nearest full station

114 = Distance between points, expressed in stations.
1.026 = Distance × 9, starting one place to right, always.

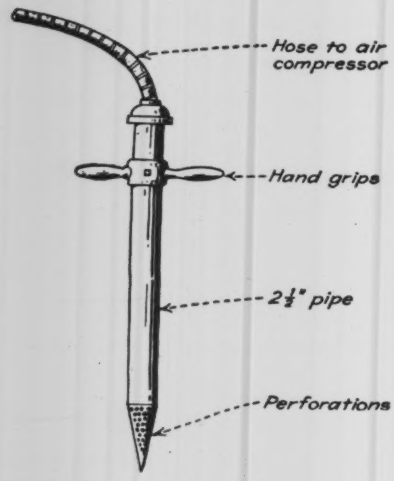
2.166 = Adding and pointing off 3 places, always, gives distance between points, expressed in miles.

This method gives results correct to the nearest tenth of a mile, within the usual range of distances between points on highway projects, which is as close as a speedometer registers.—Ellis A. Hoffauir, *Dunn Construction Co., Jackson, Miss.*

Air Jet Washes Gravel

The air jet illustrated, supplied with air from a portable compressor is being used with a substantial saving of time and labor to clean gravel beds found shallowly submerged along many Ohio streams. Much of this gravel is found in eddy waters in which the current is too sluggish to keep the deposit clean enough for use in construction. The air jet is operated from shore or a float throughout the area to be worked by inserting the point 6 to 8 in. into the gravel at about 3-ft. intervals. At each insertion the air is turned on until the gravel is well stirred up and the water is thoroughly roiled and the dirt is floated off by the cross- and counter-currents created by the turbulence caused by the air from the jet.

For depths to 30 in. from 3 to 8-lb. pressure is adequate; added pressure is required in deeper water. When the area of bed to be worked has been jetted the top layer of gravel is excavated and another lift is jetted. A gravel remarkably clean to the depth of agitation is produced by the jetting operation.



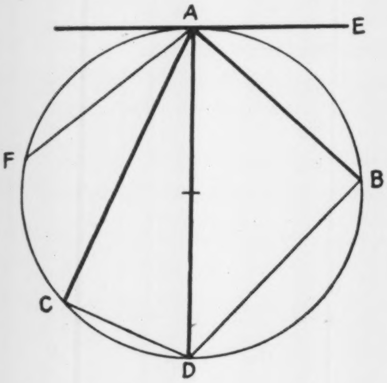
Air jet for washing underwater gravel.

The jet is homemade from about a 6-ft. length of 1½-in. pipe; one end is cut into four gores that are bent in and welded to a point and the other end is threaded for a hose connection. Small holes drilled in the pointed end and hand grips clamped about a foot from the top complete the jet.—F. R. Cozzens, *Stockport, Ohio.*

Grades for Road Drainage

In preparing highway plans, especially in connection with the laying out of intersections or the planning of drainage, it is sometimes desirable to determine the direction in which water will flow across the surface, or to determine the rate of grade along some line on the surface as is not directly ascertainable from the profile or cross-sections. In such cases the following method has at times been convenient.

Referring to the figure assume that we know the rate of grade of the road surface along two lines such as *AB* and *AC*, and that it is desired to find the direction in which the rate of grade is a maximum and the magnitude of the maximum grade. Make the lengths of the lines *AB* and *AC* proportional to the rates of grade in their respective directions—that is, one unit of length corresponds to one percent of grade. At *B* erect a perpendicular line to the line *AB* and at *C* erect a perpendicular to the line *AC*, the two perpendiculars intersecting at *D*. Draw the line *AD*, which will measure the magnitude and direction of the maximum grade on the surface, and of course indicate the direction in which it will drain. The line *AE*, perpendicular to *AD*, will indicate the direction in which the surface is level.

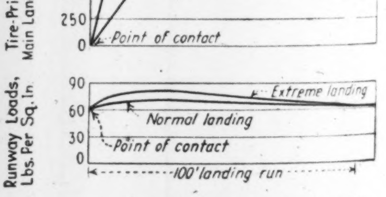


If it is desired to know the rate of grade along some other line such as *AF*, construct a circle with *AD* as a diameter. The length of the line *AF* is a measure of the rate of grade in that direction. — Thomas C. Coleman, *Junior Civil Engineer, Massachusetts Dept. of Public Works.*

Landing Loads on Runways

Accompanying chart, developed by W. R. Macatee of the Asphalt Institute from data assembled by engineers of the Douglas Aircraft Co., indicates that for any condition of loading on airport surfaces, short of crash landings, the unit loads on the runway remain almost constant. This is because the tire-print area of each main landing wheel increases about in proportion to the impact of landing.

Since the pressure in airplane tires is not expected to exceed 75 lb. per sq.in. despite the size of the plane, this chart may be used for almost any condition of loading with planes of all sizes now contemplated.



Top curves show total load per landing wheel, middle curves tire-print area of each landing wheel, and lower curves load on runway in lbs. per sq.in. for DC-4 type plane with a 100-ft. landing, which usually requires 0.95 to 1.20 seconds.

Master Straightedge for Checking Wood Straightedges

Metal master straightedge is attached to frame of longitudinal float for frequent checking of wood straightedges used to meet the ⅛-in. in 16 ft. tolerance permitted on Pennsylvania Turnpike paving. This gadget is on the Wm. O'Neil Sons Co. contract.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

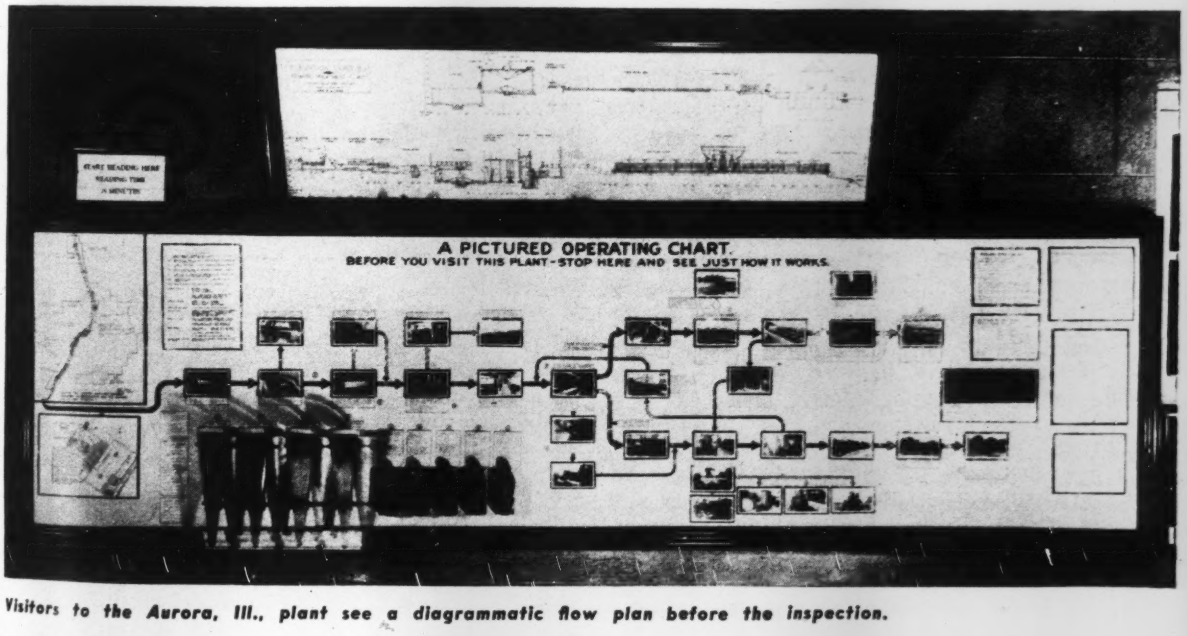
FILTER DISTRIBUTORS—The question whether material differences are noticeable when sewage is passed through filters from stationary jets, water-wheels and rotary distributors by jets or sprays has been raised many times. Hewitt (*The Surveyor*, Oct. 25, 1940) states that at Birmingham it had been shown by experience, that water-wheel machines with spray distribution caused more surface growth and ponding. Traveling jet distribution is considered preferable.

VISITORS—Lay visitors to a sewage treatment plant are often bewildered by the various types of tanks and do not receive a clear impression of the function of the different units. Walter A. Sperry, superintendent at Aurora, Ill., has placed on view a flow diagram using photographs which show the function of the units. Typewritten material under the pictures give brief explanations, while an abridged history of the Sanitary District is shown at the right side; cost of treatment, amount of work done per day, and benefits to the receiving stream are shown on the left.

The chart, shown in the accompanying illustration, measures 2½ by 10 ft., is mounted on beaver board and attractively framed. In all cases great care is taken to write all descriptive notes in the simplest possible language with few technical terms. In addition some Imhoff cones and photographs of bacteria developing from a drop of sewage are shown. After viewing this exhibit the visitor is guided on the grounds by a series of printed statements mounted on beaver board and framed without glass, but lacquered to prevent sweating and molding.

INDUSTRIAL POLLUTION—In a series of reports published by the Work Projects Administration and sponsored by the Massachusetts State Department of Health the sources of pollution in various rivers in Massachusetts have been recorded. Detailed information on pollution sources in the Connecticut Valley and the condition of the river and its tributaries shows that over 50,000,000 gallons of industrial wastes are discharged daily in addition to the sewage from some 420,000 people. The principal wastes are those usual to the manufacture of paper products, light and heavy metals, and process waters from woolen manufacture. Only 5 percent of these wastes are discharged into municipal sewerage systems, where they could be subject to treatment prior to river discharge. The 95 percent discharged through private sewers leave any clarification, neutralization or oxidation to the natural purification processes in the stream. Recently, plans for sewage treatment processes have been approved, plants are under construction or have been built, which will result in at least primary treatment of the sewage from 202,000 people. The real problem in Massachusetts, as elsewhere, is treatment of industrial wastes.

SEWER CHARGE ORIGINATOR?—Fayetteville, N. C., was one of the first communities in this country to adopt a sewer service charge in order to finance construction and maintenance of sewers. In a recent conversation with J. L. Weathers, manager of the Public Works Commission of that city, it was revealed that Fayetteville had been making such a charge since 1910. Until recently the charge per connection was $1 per quarter, listed on and payable with the water bill. Now the fee is 35 cents per month. No other assessment for sewer installation or service ever has been made. Does any other city claim "first" in sewer charges? — E. J. CLEARY.


A PICTURED OPERATING CHART.
BEFORE YOU VISIT THIS PLANT—STOP HERE AND SEE JUST HOW IT WORKS.

Visitors to the Aurora, Ill., plant see a diagrammatic flow plan before the inspection.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

A New Type of Year Book

1941 YEAR BOOK—Published by the New York State Society of Professional Engineers, Grand Central Terminal, New York. Price $10.

Something new in the way of society year books has been produced by the New York State Society of Professional Engineers in this first of what is expected to be an annual volume. In addition to the normal content of a year book, there are reproduced in this one sections of the state education law with respect to licensing of engineers, recent court decisions of interest to engineers, excerpts from the administrative code of New York City and from the zoning regulations, excerpts from the state, labor, lien and penal laws, and regulations of the state department of health having to do with sanitary engineering. Welding symbols and standard abbreviations also are included. In the foreword, Frederick H. Zurmuhlen, president of the society and editor-in-chief of the year book, states that new materials of similar character is to be included each year. Thus the society hopes to provide its members with a library of useful information not easily available elsewhere in such convenient form.

In the listing of members, the type of work in which each is engaged or in which he specializes is given.

Looking Into the Future

TECHNOLOGY AND SOCIETY—By S. McKee Rosen and Laura Rosen. 474 pp. Published by thte Macmillan Co., New York. Price $4.

This book has been compiled from a vast amount of printed material on technological trends in an effort to give students a text to use in their social science studies to get some grasp of the effect of machines and past developments in engineering on the life of this country as well as to help them in attempting to determine what effect present developments or trends may have on the future. As to the first of these objectives, the book probably covers a difficult subject as well as could be done in the limited space available. But when it comes to attempting to indicate what current trends appear to be significant in shaping future social developments, the author's findings are unconvincing in so far as they apply to the field of civil engineering and construction.

The Record of a Full Life

ROBERT RIDGWAY—An autobiography. 370 pp. Privately published by Isabel Law Ridgway, New York.

Another of those all too rare records of the life of an active engineer is made available to future generations by the posthumous publication of the autobiography of Robert Ridgway. In the years following his retirement from active work, Mr. Ridgway had dictated the manuscript to Mrs. Ridgway at irregular intervals and had carried the record up through 1936, but had not undertaken its review and revision when he died in December, 1938, while returning from the ground-breaking ceremony for the Chicago subway.

The character of the man shines through the record; the stranger picking it up would know that Robert Ridgway was fond of people rather than things. This is shown clearly by the facility with which he recalled the names and characteristics of rodmen or axemen with whom he was associated in the West in the early days of his engineering career. Similarly, in his account of work on New York's water supply and subway systems, though he tells much of interest from an engineering angle, it is of the men, their weaknesses or strong characteristics, that Mr. Ridgway writes most interestingly.

The present edition has been limited to distribution among Mr. Ridgway's many friends and a few libraries. It is to be hoped that some such agency as the Engineers Council for Professional Development will be permitted to give the book a much wider distribution. It is a record that cannot but inspire young men starting out in engineering, some of whom may feel that the lack of fortune or formal education is a bar to high place in the engineering profession.

New Engineering Books

ANALYTICAL MECHANICS FOR ENGINEERS—By Fred B. Seely and Newton E. Ensign. Third Edition, Rewritten. 450 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, London. Price $3.75.

CONTRIBUTIONS TO SOIL MECHANICS—1925-1940. 413 pp. Published by the Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass. Price $1.75.

THE RAILROAD PROBLEM AND ITS SOLUTION—By John E. Muhlfeld. 320 pp. Published by The Devin-Adair Co., 23 East 26th St., New York. Price $3.

AMERICAN PLANNING AND CIVIC ANNUAL — 1940 — Edited by Harlean James. 278 pp. Published by the American Planning and Civic Association, 901 Union Trust Bldg., Washington, D. C. Price $3.

TECHNOLOGY AND SOCIETY—By S. McKee Rosen and Laura Rosen. 474 pp. Published by The Macmillan Co., 60 Fifth Ave., New York. Price $4.

AMERICAN SOCIETY FOR TESTING MATERIALS—Proceedings of the Forty-Third Annual Meeting. 1,396 pp. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Price $9 to non-members.

ELEMENTARY STRUCTURAL ENGINEERING—By Leonard C. Urquhart and Charles E. O'Rourke. 348 pp. Published by McGraw-Hill Book Co., New York and London. Price $3.

DESCRIPTIVE GEOMETRY—By A. S. Levens and H. C. T. Eggers. 240 pp. Published by Harper & Brothers, New York and London. Price $2.50.

Reports and Pamphlets

APPLICATION OF THE PRINCIPLE OF DISPERSION TO PORTLAND CEMENT—Research Paper No. 35. Published by the Master Builders Research Laboratories, 7016 Euclid Ave., Cleveland, Ohio.

FUNDAMENTAL ECONOMIC ISSUES IN NATIONAL DEFENSE—Published by The Brookings Institution, Washington, D. C. Price 25c.

TURBULENT FLOW OF SLUDGES IN PIPES—Bulletin Series No. 323. Pub-

(Continued on p. 74)

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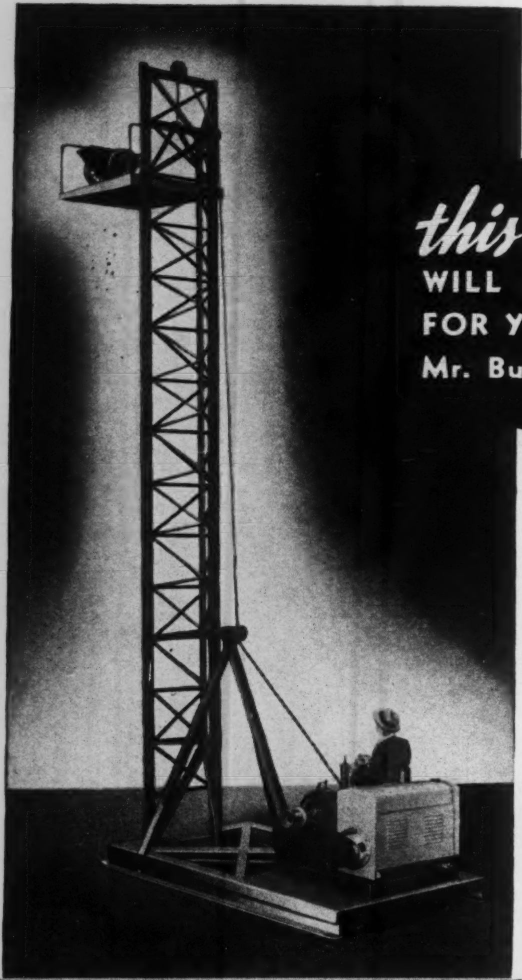

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1. **Compact — Tower and Hoist mounted as a unit on steel skids.**
2. **Construction — welded steel throughout — greatest strength, no excess weight.**
3. **Can be set up and working two hours after it reaches the job.**
4. **No guys; easy to erect. Short moves can be made without lowering the tower.**
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(Continued from p. 72)

lished by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Price 45c.

STABILIZED ROADS—Published by the Bureau of Mines, Dept. of Mines and Resources, Ottawa, Ont., Canada. Price 25c.

GEODETIC SURVEY OF GLYNN COUNTY, GEORGIA—1940. Published by the Glynn County Planning Board.

PROPOSED ARTERIAL HIGHWAY SYSTEM FOR ALASKA—By Wm. A. Hesse, Territorial Highway Engineer, Juneau, Alaska.

INCOME AND EXPENDITURES OF GOVERNMENT IN CALIFORNIA—1900-1940. Published by the California Taxpayers' Association, Los Angeles, Calif.

CONCRETE PIPE FOR AIRPORT DRAINAGE—Bulletin 22. Published by the American Concrete Pipe Association, 33 West Grand Ave., Chicago, Ill.

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA—Report for the period July 1, 1938 to June 30, 1940.

THE PORTS OF PORT ARTHUR, SABINE, BEAUMONT, AND ORANGE, TEXAS (No. 14, 60c.); CHARLESTON, S. C. (No. 9, 60c.); WILMINGTON, N. C. (No. 33, 35c.); ASTORIA, OREGON AND LONGVIEW AND VANCOUVER, WASHINGTON (No. 32, 75c.); SAVANNAH AND BRUNSWICK, GA. (No. 10, 55c.). Compiled by the Board of Engineers for Rivers and Harbors, War Department and the United States Maritime Commission. For sale by the Superintendent of Documents, Washington, D. C.

THE AXIAL ADJUSTMENT OF DEEP-WELL TURBINE PUMPS—Published by University of California Press, Berkeley and Los Angeles.

SCOPE OF REGIONAL PLANNING—Published by the Department of Fine Arts, Harvard University.

SOURCES OF POLLUTION TAUNTON RIVER VALLEY—Prepared by the Work Projects Administration Pollution Studies Project, 115 Federal St., Boston, Mass.

INFILTRATION OF WATER INTO THE SOIL—Soil Conservation Bibliography No. 3. Available for limited distribution from: Division of Information, Soil Conservation Service, U. S. Dept. of Agriculture, Washington, D. C.

EFFECTS OF WEATHER AND HEAVY LOADS ON PAVEMENTS—Published by the National Highway Users Conference, National Press Bldg., Washington, D. C.

PROCEEDINGS of the Fourteenth Annual Conference of The Maryland-Delaware

Water and Sewerage Association, Salisbury, Md. 1940.

TOWARD MORE HOUSING — Monograph No. 8, Temporary National Economic Committee, Washington, D. C.

HANDBOOK OF FEDERAL LABOR LEGISLATION—Bulletin No. 39, Part I. For sale by the Superintendent of Documents, Washington. Price 35c.

SOME PRINCIPLES OF ACCELERATED STREAM AND VALLEY SEDIMENTATION—Technical Bulletin No. 695. Published by the U. S. Dept. of Agriculture and for sale by the Supt. of Documents, Washington. Price 75c.

WILMINGTON, DEL.—Annual Report and Statement, 1940.

THE ENGINEERING FOUNDATION—Annual Report 1939–1940. Published by the United Engineering Trustees, 29 West 39th St., New York City.

SYRACUSE GRADE CROSSING COMMISSION 1940—Annual Report, Syracuse, N. Y.

WELDING RESEARCH COMMITTEE OF THE ENGINEERING FOUNDATION—Welding Research Committee, 29 West 39th St., New York City.

CONCRETE GRANDSTANDS—May be obtained from the Portland Cement Association, 33 W. Grand Ave., Chicago.

TECHNICAL JOURNALISM AT IOWA STATE COLLEGE—The Iowa State College Bulletin, Ames, Iowa.

BEITRAGE ZUR THEORIE UND BERECHNUNG VON BALKENBRUCHEN AUS EISENBETON—By Dr. Mohamed Hilal. Published by A. G. Gebr. Leemann & Co., Zurich and Leipzig. Price Fr. 15.

LAWS OF THE UNITED STATES RELATING TO THE IMPROVEMENT OF RIVERS AND HARBORS—Letter from The Secretary of War. Compiled in the Office of the Chief of Engineers, U. S. Army. Vol. 3 from 1913–1939.

THE ECONOMIC EFFECTS OF THE FEDERAL PUBLIC WORKS EXPENDITURES, 1933–1938. 131 pp. Published by The National Resources Planning Board, Washington, D. C. For sale by the Superintendent of Documents, Washington, D. C. Price 25c.

NATIONAL RESEARCH COUNCIL: American Geophysical Union, Transactions of 1940. Part I: Reports and Papers; Joint Regional Meeting; Section of Hydrology and Western Interstate Snow-Survey Conference. Part II: Twenty-First Annual Meeting; Reports and Papers; General Assembly and Sections of Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology, Hydrology and Tectonophysics. Part III: Regional Meetings, Reports and Papers, Western Interstate Snow-Survey Conference and Section of Hydrology. Part IV: Regional Meeting, Symposia under Auspices of the American Association for the Advancement of Science: (A) Applications of Mathematics in the Earth-Sciences and (B) Hydrologic Problems in the Ohio and Michigan Basins. Published by The National Research Council of The National Academy of Science, Washington, D. C.

URBAN GOVERNMENT—Volume I of the Supplementary Report of the Urbanism Committee to the National Resources Committee. 303 pp. For sale by the Superintendent of Documents, Washington, D. C. Price 50c.

CURRENT ADDITIONS to the pamphlets entitled "Building Materials and Structures" include: "Effects of Wetting and Drying on the Permeability of Masonry Walls"; "A Survey of Humidities in Residences"; "Roofing in the United States—Results of a Questionnaire"; "Properties of Adhesives for Floor Coverings"; "Structural Properties of a Precast Joist Concrete Floor Construction Sponsored by the Portland Cement Association"; and "Plumbing Manual." These pamphlets are published by the National Bureau of Standards and are for sale by the Superintendent of Documents, Washington, D. C. for 10c with the exception of the "Plumbing Manual", which is 20c.

AMERICA'S SOURCES OF POWER AND NATIONAL DEFENSE—Engineering Experiment Station Circular No. 30, Engineering Experiment Station, Ohio State University, Columbus, Ohio.

SMALL IRRIGATION PUMPING PLANTS—Published by the U. S. Department of Agriculture, Washington, D. C. Farmers' Bulletin No. 1857.

SCALE FORMATION IN WATER HEATERS AND METHODS OF PREVENTION—Research Series No. 74. Published by the Engineering Experiment Station, Purdue University, Lafayette, Ind.

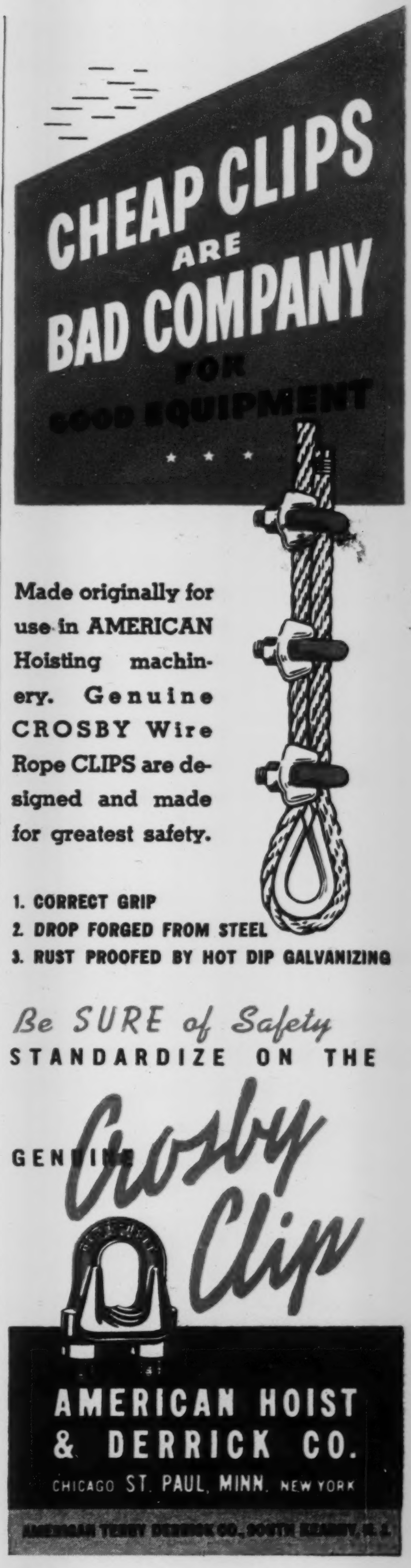
TEXAS HIGHWAY FACTS—Prepared by the Texas State Highway Department (Austin) in cooperation with the Public Roads Administration.

TEMPORARY CONSTRUCTION AT MILITARY POSTS—Specifications for construction of temporary buildings at Municipal Airport, Tucson, Ariz. U. S. Engineer Office, Los Angeles, Calif.

DIRECTORY of State, Territorial and Regional Planning Agencies and State Defense Agencies. Prepared by the National Resources Planning Board, Washington, D. C.

DESIGN AND CONSTRUCTION DATA BRICK CAVITY WALLS—Published by the Brick Manufacturers Ass'n, 2721 Grand Central Terminal, New York.

AUTOMOBILE FACTS AND FIGURES—1940. Published by the Automobile Manufacturers Association, New Center Bldg., Detroit, Mich.



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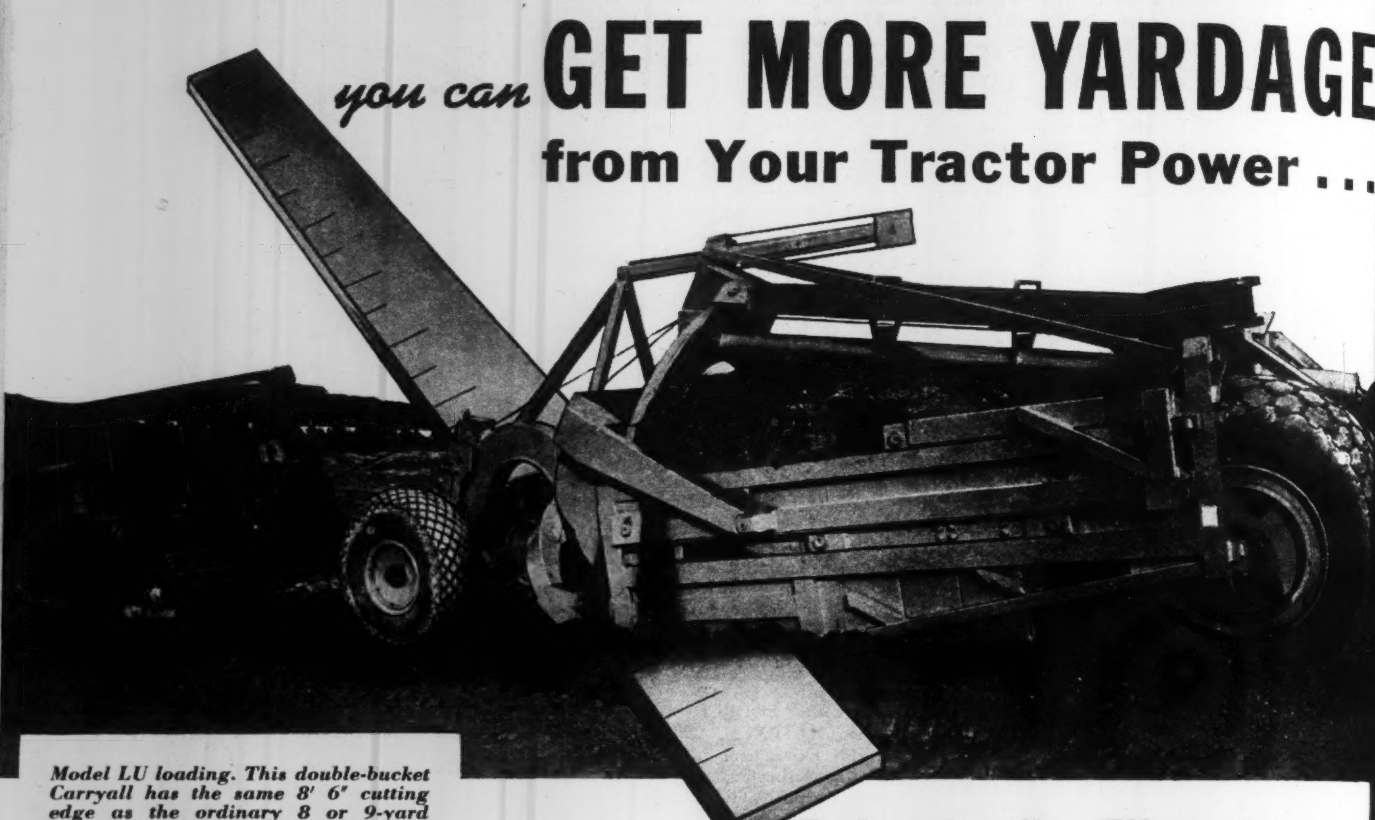
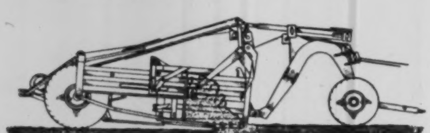
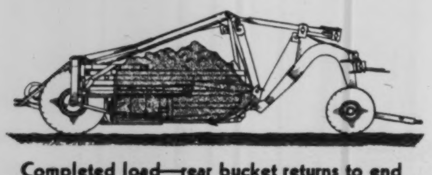
With LeTourneau DOUBLE-BUCKET CARRYALLS *you can* GET MORE YARDAGE from Your Tractor Power . . .



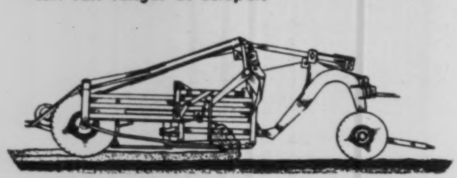
Model LU loading. This double-bucket Carryall has the same 8′ 6″ cutting edge as the ordinary 8 or 9-yard scraper, requires no more loading power than the normal 12 to 15-yard scraper, but has a capacity of 19 heaped yards.



Start of load—telescoping bucket in forward position. Notice that material piles up at rear of scraper bucket.



Completed load—rear bucket returns to end of scraper on roller bearings, carrying material full length of scraper.



Complete ejection—rear bucket also moves forward, with ejection tailgate wiping sides and bottom clean of all load.

Made in 4 Sizes

*LU	19 yard heaped capacity for D8 or B Tournapull
**FU	23 yard heaped capacity for D8
**RU	30 yard heaped capacity for D8 or A Tournapull
**NU	45 yard heaped capacity for D8 or A Tournapull

*8′6″ cutting edge   **10′ cutting edge

Reduce Loading Effort • Increase Yards per Horsepower • Proved by 4 Years' Use

You get more yardage from your tractor power because loading a double-bucket, in effect, is like loading two small scrapers one after the other. To begin loading, the rear bucket telescopes forward (see operating sketches). The material loaded into this shortened bowl travels back on rollers and roller bearings instead of being forced back. Result: less loading resistance plus a larger and better heaped load, with no empty corners.

Smart, Load-Expanding Design

The yardage you can put into a conventional single bucket scraper with 90 to 100 H.P. naturally is limited by:

1. **Bowl height**
2. **Width of cutting edge**
3. **Bowl length**

Practical experience has fixed bowl height at 4 to 5 feet. Shipping requirements limit cutting widths to 10 feet maximum. And, until the advent of the double-bucket Carryall, the power required to force dirt back pretty well limited bowl length. Then came the revolutionary LeTourneau double-bucket Carryall. With this revolutionary double-bucket design, you retain the same bowl height . . . can use the power-saving, narrower cutting edge of a conventional 8 or 9-yard scraper . . . yet, because power is conserved by this unique method of loading into one bowl and rolling it back, you're able to expand bowl length and increase capacity as much as 50%.

It's proved by 4 years of use by leading contractors the country over. Plenty of repeat orders show it's a profit-maker. Simple, easy to operate. Patented and available only from LeTourneau. Ask your LeTourneau-"Caterpillar" dealer to show you how a double-bucket Carryall can step up your yardage. See him NOW.

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***For Lowest Net Cost per Yard*-CARRYALL* SCRAPERS, ANGLEDOZERS*, CRANES, BULLDOZERS, POWER CONTROL UNITS, DRAG SCRAPERS, PUSHDOZERS, SHEEP'S FOOT ROLLERS, ROOTERS*, TOURNAPULLS*, TOURNATRAILERS*, TOURNACRANES.** **Name Reg. U. S. Pat. Off.*

MEN AND JOBS

P. H. Barnes, Jr., senior draftsman in the bridge department of the North Carolina State Highway and Public Works Commission since 1931, was appointed Jan. 24 as contact engineer with the WPA, a newly-created post.

Hal G. Sours, chief engineer, Ohio Department of Highways, has been named a member of the motor transport committee of the American Association of State Highway Officials, which will make a study of the country's highways necessary for national defense.

Lt. Comdr. **Leslie J. Watson**, civil engineer and superintendent of Comdr. Alexander and Baldwin, Ltd., Honolulu, T.H., has been called to service with the civil engineer corps, U. S. Navy. Commander Watson is now connected with the Western Pacific airbase projects.

Carl A. Sinclair, engineer of the Territorial Public Works Department and former PWA administrator for Hawaii, has been appointed director of the Territorial Planning Board to succeed **Mr. Joseph F. Kunesh**, who resigned recently to become city-county engineer.

B. F. Forrester has been appointed chief engineer for Sikeston, Mo., succeeding **F. J. Noona**, who died recently. Mr. Forrester had been serving as assistant to Mr. Noona.

R. A. Gravelle has been named engineer of maintenance-of-way for the Canadian National-Great Western Railway.

Allan F. Turpin has been transferred from the U. S. Engineer Office at Peoria, Ill., to the Kankakee Ordnance Works, near Joliet, Ill., where he is working as assistant engineer with the Quartermaster Corps.

E. E. Larson, civil engineer, has resigned his position as associate engineer with the Kansas State Highway Comission, to accept the position of county engineer of Douglas County, Lawrence, Kan. Previous to August 1941 Mr. Larson was district concrete engineer for the Pennsylvania Turnpike Commission. He is a graduate of Kansas State College.

Lt. Col. **Harold Butzine**, civil engineer, with the Hawaiian Dredging Co., Honolulu, T. H., has been called into active service with the civil engineer corps, U. S. Navy. Lieut. Butzine is now connected with the western Pacific airbase projects.

Joseph F. Kunesh has resigned his position as director of the Territory of Hawaii planning board to accept the post of city-county of Honolulu engineer. He will replace former city-engineer **Ben F. Rush**.

Lt. Col. **John D. Kilpatrick** has been appointed chairman of the Honolulu Park Board. Col. Kilpatrick entered the army during the World War and spent ten months in France. Before going to France he had charge of the layout and construction of Camp Wadsworth at Spartanburg, S. C., and in 1935 had charge of layout of the water supply system for Schofield Barracks, Hawaii. He retired from active duty June 30, 1938.

Lyman H. Bigelow has been appointed superintendent of buildings of Honolulu, T. H., having replaced **A. W. Heen**.

L. V. Bean, city manager, Waycross, Ga., has been made lt. col. in the U. S. Engineering Corps.

J. Wm. Moffett has resigned as supervising engineer and chief structural engineer with the United Engineers & Constructors, Inc., Philadelphia, Pa., and has joined the organization of Giffels & Vallet, Inc., Detroit, Mich. Mr. Moffett is now located at St. Louis, Mo., as chief engineer for Mauran, Russell, Crowell & Mullgardt, architects and Giffels & Vallet, Inc., engineers, on the St. Louis ordnance plant.

Charles W. Kling has been named engineer of the first field area, U. S. district engineer office, Mobile, Ala., and will have headquarters at Tuscaloosa. Mr. Kling has been connected with the engineering department since 1919, after graduating from the University of Alabama in civil engineering. He succeeds **Capt. George Zimmerman**, who has been transferred to the Mobile area.

Howard W. Holmes has been appointed state highway engineer by Governor Sam C. Ford of Montana. He succeeds **Don A. McKinnon**. Mr. Holmes served as chief engineer for the Montana State Highway Commission from 1923 to 1927, and since that time he has been associated with the Louisiana and California highway departments.

Herbert H. Brown, engineer in charge of design and construction of the pumping station and new filtration plant for the city of Milwaukee, has been named superintendent of the city waterworks to succeed **Henry P. Bohmann**, who re-

(*Continued on p. 82*)

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Fast-acting, patented 2-line control enables you to operate apron lift independently of tailgate, thus fill scraper bowl regardless of material. LeTourneau Power Control Unit is unaffected by heat or cold. More than 10,000 now in use.

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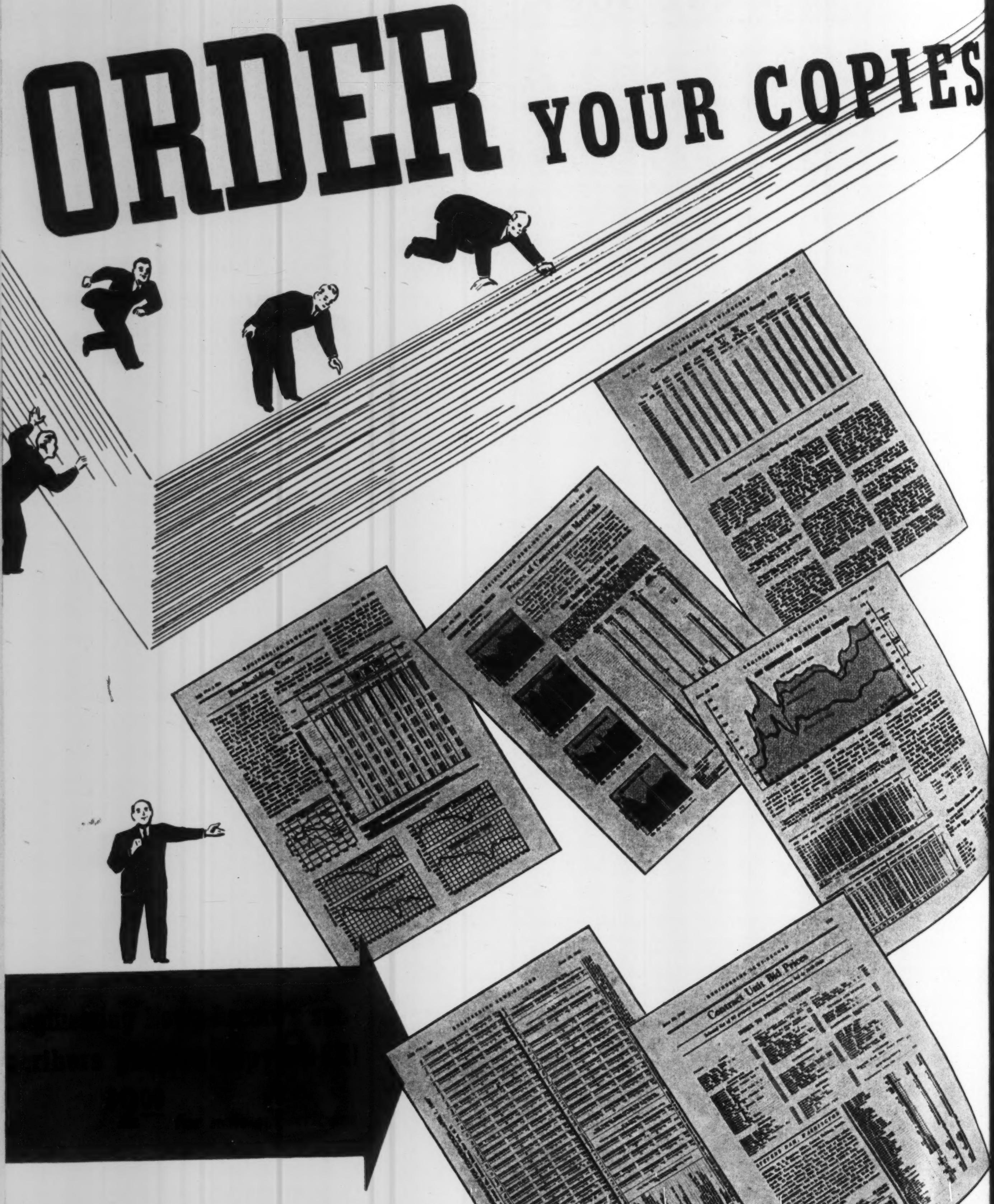
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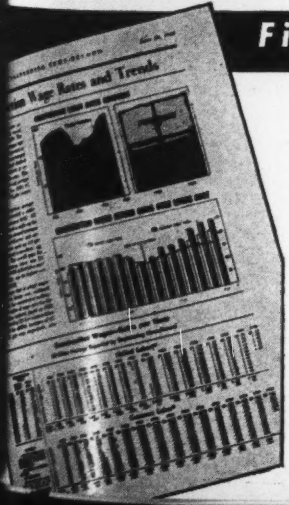

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

THAMES RIVER BRIDGE CONNECTICUT

OWNER: Connecticut State Highway Department, Hartford.

PROJECT: Construction of substructure and superstructure for 6,300-ft. cantilever, steel, reinforced concrete toll bridge over Thames River between Groton and New London, Conn. Project involves construction of approaches. New London approach crosses many streets and is curved for first 250-ft. Main piers 76½ by 41½-ft.; bottom 60-ft. below mean low water; on steel "H" beam piles ranging from 100 to 122 ft.

CONDITIONS: Contractor to furnish all materials. Approach piers to be completed by Sept. 1, 1941; substructure by April 1, 1942; and superstructure by Nov. 1, 1942. Rail, highway and water transportation facilities available. Wage rates are: skilled labor, 75c. to $1.65 per hr.; semi-skilled, 68c. to $1.20; common, 50 to 55c.

BIDS: Four bids were received December 23, 1940 on substructure, ranging from the contract low of $1,487,396 to $2,089,300. Six bids were opened on the same day for the superstructure. They ranged from $2,254,925 to $2,812,508.

Substructure

LIST OF BIDDERS:

1. A. I. Savin Constr. Co., East Hartford, Conn.	$1,487,396
2. Merritt-Chapman & Scott Corp., New York, N. Y.	1,676,516
3. Dravo Corporation, Pittsburgh, Pa.	1,894,390
4. P. J. Carlin Constr. Co., New York, N. Y.	2,089,300

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clear and grub	L.S.	$75,000.00	$10,286.00	$5,000.00
2. Br. excav., west abut., piers 1 to 15	5,650 c. y.	15.00	3.00	5.00
3. Bridge excav., east abut	400 c. y.	15.00	3.50	3.00
4. Grav. fill, abuts. and piers 1 to 15	1,200 c. y.	1.00	1.20	1.50
5. Deformed steel bars, abut. and piers 1 to 15	425,000 lb.	.04	.048	.07
6. Cl. A conc., abut. and piers 1–15.	5,300 c. y.	15.00	14.00	25.00
7. Loading test piles	10 ea.	100.00	100.00	400.00
8. Soil bearing load tests	20 ea.	100.00	150.00	440.00
9. Port. cem, aubt. and piers 1–15	7,700 bbl.	2.30	2.40	2.30
10. Bridge excavation, piers 16 to 23.	3,900 c. y.	5.20	4.00	5.00
11. Bridge excavation, piers 24 to 29.	10,900 c. y.	5.00	20.00	17.00
12. Bridge excavation, piers 30 to 35.	2,600 c. y.	1.00	3.50	5.00
13. Gravel fill, piers 16 to 35	1,500 c. y.	1.00	2.00	3.00
14. Deformed st. bars, piers 16 to 35	2,100,000 lb.	.04	.06	.07
15. Cl. A conc., piers 16–23 and 30–35	10,500 c. y.	14.00	14.00	21.00
16. Foundation conc., piers 24–29	8,450 c. y.	10.25	15.00	15.00
17. Cl. A conc. for shafts, piers 24–29	15,900 c. y.	10.25	15.00	19.00
18. Dimensioned stone masonry, piers 24 to 29	13,100 s. f.	4.00	3.50	5.00
19. Sheet steel piles, piers 24 to 29	42,200 s. f.	2.54	1.60	2.00
20. Furn. st brg piles, piers. 21–31	10,600,000 lb.	.03	.032	.031
21. Drive st brg piles, piers 24–29	99,400 l. f.	.40	.60	.40
22. Drive steel brg. piles, piers 21–23 and 30 and 31	20,500 l. f.	.40	.48	.50
23. Portland cement, piers 16 to 35	51,400 bbl.	2.30	2.40	2.30

Superstructure

LIST OF BIDDERS:

1. Harris Structural Steel Co., New York, N. Y.	$2,254,925
2. American Bridge Co., New York, N. Y.	2,292,273
3. Bethlehem Steel Co., Bethlehem, Pa.	2,377,645
4. Phoenix Bridge Co., New York, N. Y.	2,610,430
5. Mt. Vernon Bridge, Mt. Vernon, Ohio	2,715,265
6. R. C. Mahon Co., Chicago, Ill.	2,812,508

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Deformed steel bars	2,550,000 lb.	$0.0475	$0.0455	$0.049
2. Wire fabric for sidewalk	2,900 s. y.	.50	.40	.40
3. Struct. carbon steel, spans 1–15	4,500,000 lb.	.054	.0615	.0626
4. Metal bridge railing	12,600 l. f.	12.00	7.50	8.50
5. Class A concrete	9,350 c. y.	19.50	20.25	20.00
6. Portland cement	13,500 bbl.	2.40	2.50	2.53
7. Str. carbon steel, girder spans 16–21 and 33–36 incl	2,550,000 lb.	.055	.0611	.0704
8. Str. silicon steel, girder spans 16–21 and 33–36 incl	1,250,000 lb.	.062	.0718	.0809
9. Str. carbon steel, truss spans 22–32 incl	4,950,000 lb.	.0735	.0693	.0745
10. Str. silicon steel, truss spans 22–32 incl	11,700,000 lb.	.0805	.0848	.0848

DREDGING, CONNECTICUT

OWNER: U. S. Engineer Office, Providence, R. I.

PROJECT: Removing ledge rock and dredging material other than ledge rock in New Haven Harbor, Conn. Site of work is on west limit of main channel between East Breakwater and Luddington Breakwater, roughly due west of Southwest Ledge Light. Contract includes removal and disposal of all material lying above plane of 26 feet below mean low water.

CONDITIONS: Contractor to furnish all material and plant required for work, and complete in 45 days after notice to proceed. Minimum wages specified are: skilled labor, 66½c. to $1.125 per hr.; semi-skilled, 55c.; common, 50c.

BIDS: Two bids were received January 15, 1941, $13,503 and $19,600. Engineer's estimate, $7,464.

LIST OF BIDDERS:

1. P. Sanford Ross, Inc., Jersey City, N. J.	$13,503
2. Elliott & Watrous, Inc., Providence, R. I.	19,600

Item	Quan.	Unit Prices (1)	(2)	(3)*
1. Ledge rock	100 c. y.	$96.45	$140.00	$70.00
2. Material other than ledge rock	40 c. y.	96.45	140.00	11.60

* Engineer's estimate.

HIGHWAYS, CALIFORNIA

OWNER: California State Highway Department, Los Angeles.

PROJECT: Grading and placing asphaltic concrete on cement treated base on portion of Routes 19 and 78, Riverside County, Calif. Length of project 1.5 miles.

CONDITIONS: Contractor to furnish all materials and complete work in 125 days. Highway transportation available. Wage rates stipulated are: skilled, $1.00 to $1.50 per hr.; semi-skilled, 75c. to $1.00; common, 62½c.

BIDS: Five bids were received January 16, 1941, ranging from the contract low of $44,092 to $58,170.

LIST OF BIDDERS:

1. Oswald Brothers, Los Angeles, Calif.	$44,092
2. F. Gunner Gramatky, Pasadena, Calif.	47,885
3. J. E. Haddock, Ltd., Pasadena, Calif.	48,141

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clear and grub	96 sta.	$2.00	$3.00	$2.50
2. Remove concrete	160 c. y.	1.00	3.00	1.25
3. Develop water supply; furnish equip	L.S.	400.00	800.00	250.00
4. Applying water	1,394 M gal.	.85	.60	.85
5. Roadway excav.; unclass	25,000 c. y.	.18	.20	.19
6. Overhaul	20,000 sta. y.	.01	.01	.01
7. Excav.; structures	1,600 c. y.	.75	1.00	.75
8. Ditch and channel excav	100 c. y.	.75	1.00	.65
9. Imported borrow	15,500 c. y.	.45	.40	.49
10. Finishing roadway	96 sta.	5.00	4.00	3.00
11. Cement treated base	27,000 s. y.	.10	.10	.11
12. Portland cement for treat. base	2,550 bbl.	1.80	1.90	2.00
13. Liquid asph., RC–1, RC–2 or RC–3	20 ton	25.00	20.00	24.00
14. Mineral aggregate (plant mix. surf.)	5,810 ton	2.20	2.55	2.45
15. Liquid asph., SC–4, SC–5 or SC–6	290 ton	9.00	8.50	9.50
16. Bar reinforcement steel	2,400 lb.	.07	.06	.05
17. Cl. A Port. Cement conc. struct	50 c. y.	25.00	22.00	30.00
18. 18-in. rein. conc. pipe (4,000D)	230 l. f.	2.25	3.00	3.30
19. 24-in. rein. conc. pipe (1,500D)	128 l. f.	2.75	3.50	3.00
20. 24-in. rein. conc. pipe (2,000D)	69 l. f.	3.00	3.50	3.25
21. 24-in. rein. conc. pipe (3,000D)	132 l. f.	3.00	4.00	3.85
22. 30-in. rein. conc. pipe (2,000D)	128 l. f.	4.00	5.70	4.60
23. 30-in. rein. conc. pipe (3,000D)	53 l. f.	4.00	5.80	5.70
24. 36-in. rein. conc. pipe (2,000D)	53 l. f.	5.00	7.00	7.00
25. 48-in. rein. conc. pipe (3,000D)	94 l. f.	10.00	10.00	9.90
26. 18-in. plain conc. pipe	414 l. f.	.80	1.80	1.45
27. Salvage exist. pipe culverts	144 l. f.	.50	1.00	.35
28. Relay salv. pipe culv. (corr. met.)	76 l. f.	.50	1.00	.30
29. Culvert markers	25 ea.	3.00	3.00	3.00
30. Guide posts	23 ea.	3.00	3.00	2.75
31. Laminated guard rail	48 l. f.	1.50	2.00	1.30
32. Right-of-way monuments	22 ea.	3.00	3.00	3.00